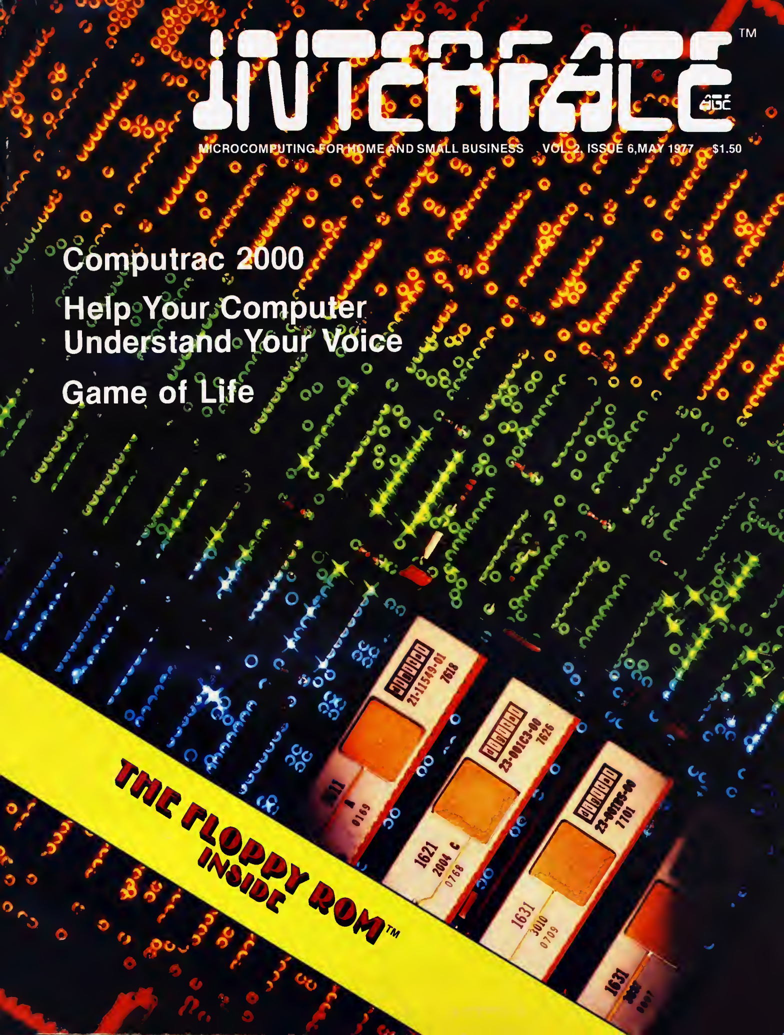
INTERFACE™ AGC

MICROCOMPUTING FOR HOME AND SMALL BUSINESS   VOL. 2, ISSUE 6, MAY 1977 $1.50

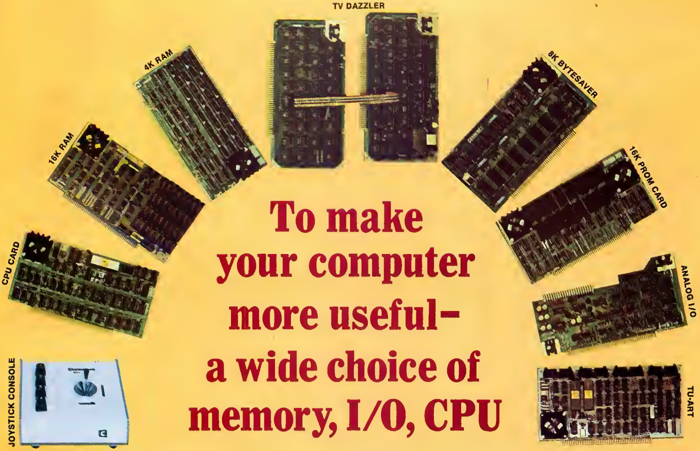
Computrac 2000

Help Your Computer Understand Your Voice

Game of Life



THE FLOPPY ROM™ INSIDE



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• 4K RAM. Bank-select allows expansion to 8 banks of 64K bytes each. Kit (Model 4KZ-K): $195. Assembled (Model 4KZ-W): $295.

• THE BYTESAVER — an 8K capacity PROM card *with integral programmer*. Uses high-speed 2708 erasable PROMs. A must for all computers. Will load 8K BASIC into RAM in less than a second. Kit (Model BSK-0): $145. Assembled (Model BSW-0): $245.

• 16K CAPACITY PROM CARD. Capacity for up to 16K of high-speed 2708 erasable PROM. Kit (Model 16KPR-K): $145. Assembled (Model 16KPR-W): $245.

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• TV DAZZLER. Color graphics interface. Lets you use color TV as full-color graphics terminal. Kit (Model CGI-K): $215. Assembled (Model CGI-W): $350.

• DIGITAL INTERFACE (OUR NEW TU-ART). Interfaces with teletype, CRT terminals, line printers, etc. Has not one but *two serial I/O ports* and *two 8-bit parallel I/O ports* as well as 10 on-board interval timers. Kit (Model TRT-K): $195. Assembled (Model TRT-W): $295.

• JOYSTICK. A console that lets you input physical position data with above Model D + 7 A/D card. For games, process control, etc. Contains speaker for sound effects. Kit (Model JS-1-K): $65. Assembled (Model JS-1-W): $95.

PROFESSIONAL QUALITY

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CIRCLE INQUIRY NO. 7

VOL. 2 ISSUE 6

MAY 1977

INTERFACE age™

MICROCOMPUTING FOR HOME AND THE SMALL BUSINESSMAN

COVER STORY

"Hidden jewels, abstract sculptures of great beauty, harmonious blendings of color schemes." Do these words describe the contents of a pharaonic tomb? They could, but in this case the eye of the present looks not upon the past's surviving glory, rather upon the present's ubiquitous artifact, a memory board.

The balanced beauty of the assembled board exemplifies the dictum that good engineering is good art. We were happy to find this specimen to use for this month's cover. The board, an LSI-II, is from Digital Equipment Corporation who also supplied the photography. Watch for an in-depth story on this computer system in a future issue.

FEATURES

PRODUCT PREVIEWS

HARDWARE FEATURES

SOFTWARE FEATURES

INTERFACE AGE Magazine, published monthly by McPheters, Wolfe & Jones, 13913 Artesia Blvd., Cerritos, Calif. 90701. Subscription rates: U.S. $10.00, Canada/Mexico $12.00, all other countries $18.00. Opinions expressed in by-lined articles do not necessarily reflect the opinion of this magazine or the publisher. Mention of products by trade name in editorial material or advertisements contained herein in no way constitutes an endorsement of the product or products by this magazine or the publisher.

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INTERFACIAL

This month INTERFACE AGE sets up a publishing milestone. Between pages 32 and 33 is a removable vinyl record which can be played on a standard record player and transferred to cassette or directly through the cassette interface into your computer.

Over six months went into the development of the process required to produce this record. The article in which the record is embedded, PLATTER BASIC by William Blomgren, describes how the "floppy-ROM" was produced, while in the following article by William Turner the theme segués into describing the implementation and language features of ROBERT UITERWYK's 4K 6800 BASIC.

Be sure to respond to the survey questions appearing on page 29 requested by the publisher.

If you are both a microcomputer and a music buff, Bob Cheeseboro has designed just the equipment for you, a microprocessor-controlled turntable.

Listening people and talking computers are numerous, but listening computers and computer-intelligible people are still rare. Owen Thomas in HELP YOUR COMPUTER UNDERSTAND YOUR VOICE explains what problems are encountered in that conversation mode.

In any mode of operation your computer relies upon ICs to accomplish its task. Roger Edelson continues his efforts to inform you in HARDWARE REPORT of the best hardware available.

Bob Stevens once more offers a useful and entertaining selection of software which he describes in his own editorial heading the SOFTWARE SECTION.

* * *

Readers, do you really agree with us all that much that you have no objections to voice nor suggestions to offer? Are we really that impeccable? Publishing is somewhat like the political process in that the publisher becomes aware that the magazine has fallen from favor when a cancellation arrives or a renewal is not made; the politician becomes aware the night of the vote tally. In both cases information flows most of the time in a one-way direction to the public and in most cases letters supply the feedback necessary for improvement.

Tell us what we do wrong — besides planting a *Printer's Devil* in a lead statement on page 16 of the April issue. Give our authors a sound rebuttal now and then; it is good for them and even better for us. Anyway, we want to hear from you.

Speaking of imps and devils, did you catch on that Roger Garrett's Remotoid *was built in A.D. 1999?*

* * *

June will feature a BIONICS special. This branch of technology is new and at times controversial, as in the case of Robotics. We feel, however, that of all the aspects of the electronic revolution, this is the most humane endeavor. As everyone now knows from the television series, bionics is the art of building operating body members for those who have had the misfortune of losing what Nature bequeathed.

Sometimes the fundamentalists feel uncomfortable with these arts and express their discomfiture through remarks such as "playing God" or "If God meant you to have a second limb, you'd grow one." It is to wonder if that same person were 22 years of age and a double amputee, would he reject Science's offer to put him back into shoesoles that tread stairs and curbs, to wear a new suit without folding back portions of it, to use the normal stalls in the men's room and to assist his infant son in taking *his* first steps.

These examples are not taken from an editor's fantasy, rather from documentable case histories. Bionics is truly a tool for the restoration of depleted dignity and destroyed hopes. It is Science in its most sublime assignment.

—L.F.S.

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UPdate

ACM — PACIFIC 77

"Exploring the Small Computer" is the theme of the conference which is expected to range in coverage from personal computing through small business applications and from computer parts and peripherals through bullet-proof software.

The conference will be held July 28-29, 1977 at LeBaron Hotel, San Jose, CA. For registration information contact the ASSOCIATION FOR COMPUTING, Box 60355, Sunnyvale, CA 94088 or General Chairman, Mr. Peter Szego, Ampex Corp., Redwood City, 415-367-3126. Deadline for paper submittal was April 1, but persons interested in submittal information, contact Dr. Robert M. McClure, Program Chairman, 14332 Maclay Ct., Saratoga, CA 95070.

NATIONAL COMPUTER CONFERENCE

More than 25,000 people are expected to gather in Dallas for a conference program of more than 100 sessions. This conference represents the year's largest display of computer hardware, software, systems and service combined with the first National Programming Contest and a series of professional seminars.

1977 National Computer Conference will take place in the Dallas Convention Center, June 13-16, 1977. Personal Computing headquarters for the 77NCC will be at Holiday Inn, Downtown Dallas. Low-cost housing is made available through Southern Methodist U. Travel packages and exhibiting information may be obtained through 77NCC, c/o AFIPS, 210 Summit Ave., Montvale, N.J. 07645 or call 201-391-9810.

INTERNATIONAL SYMPOSIUM ON COMPUTER-AIDED SEISMIC ANALYSIS AND DISCRIMINATION

A two-day conference sponsored by the IEEE Computer Society will be held at the Sheraton Inn, Falmouth, MA. The symposium will bring together scientists and engineers from the fields of geophysics, seismology, computers, signal processing and information sciences.

Advanced registration closes May 23. The $30 registration fee includes a copy of the conference record, all coffee breaks and two lunches. Late registration is $35. For further information on the symposium, write to Conference Chairman, Professor C. H. Chen, Elect. Engineering Dept., Southeastern Massachusetts U., N. Dartmouth, MA 02747.

CALL FOR PAPERS

Original papers on novel and recent developments on all aspects of computer architecture are solicited for the Fifth Annual Symposium on Computer Architecture to be held April 3-5, 1978 in Palo Alto, CA.

The symposium is sponsored by the ACM and the IEEE Computer Society in co-operation with Stanford U. Manuscripts on systems architure, new technologies, LSI architecture, I/O structures, memories, firmware, reliability and maintainability and power and packaging are requested. For submittal information contact Program Chairman, David Crockett, Hewlett-Packard, 11000 Wolfe Rd., Cupertino, CA 95914, 408-257-7000, ext. 2629.

CAMPING WITH COMPUTERS

Four one-week programs in computer programming will be offered this summer at Rose-Hulman Institute of Technology, Terre Haute, Indiana. The program, known as Camp Retupmoc, is for boys about to enter their junior or senior years in high school; it consists of lectures on BASIC programming, films on computing, and talks by computer scientists in business and industry who are making novel applications of the computer.

Dates for the Camps are June

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BASIC 8001 Is Easy To Learn. Compucolor's BASIC 8001 is a conversational programming language which uses English-type statements and familiar mathematical notations. It's simple to learn and easy to use, too. Especially when it comes to intricate manipulations or expressing problems more efficiently. The BASIC 8001 Interpreter runs in ROM memory and includes 26 statement types, 18 mathematical functions, 9 string functions and 7 command types for executing, loading, saving, erasing, continuing, clearing or listing the program currently in core.

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CIRCLE INQUIRY NO. 26

19-24, June 26- July 1, July 10-15, July 17-22. The fee, including tuition, room and board, is $125.

For further information contact Dr. John Kinney, Rose-Hulman Institute of Technology, 5500 Wabash Ave., Terre Haute, Indiana 47803.

COMPUTER CHESS NEWSLETTER

A Santa Barbara microcomputer hobbyist, Douglas L. Penrod, is seeking articles for a proposed computer chess newsletter.

Penrod hopes to pattern his newsletter after Hal Singer's *Micro-8 Newsletter.* Besides seeking articles, Penrod is also interested in receiving feedback from other hobbyists on the format the proposed newsletter should take.

Hobbyists interested in further information or contributing to the newsletter should contact: Douglas L. Penrod, 1445 La Cima Road, Santa Barbara, CA 93121.

INTERNATIONAL DATA BASE CONFERENCE

The Third International Conference on Very Large Data Bases will be held in Tokyo on October 6-8, 1977. Co-sponsors of the event are IEEE Computer Society, ACM, The Information Processing Society of Japan, the International Federation for Information Processing and the Society for Management Information Systems.

The event will be the highlight of Japan's Information Week, October 1-7 which is expected to draw more than 100,000 participants. A wide range of subjects in the field will be covered.

Reduced pre-registration rates are available until September 15. Information is available from Mr. James Gabbert, MIT Sloan School, 50 Memorial Drive, Rm. #53-330, Cambridge, MA 02139.

UPCOMING COMPUTER SHOWS MAY 77

Computer Caravan '77 has four remaining shows in New York, Philadelphia, Washington DC, and Boston. The forums will continue to be conducted by leading user or independent consultants who will lead seminars and workshops on these relevant, up-to-date topics.

Tuesday: Case studies in applying minicomputers.

Wednesday: Case studies in managing terminal networks.

Thursday: Case studies in improving software productivity.

The remaining forums will take place from 9 AM to 1 PM. Concurrently, hundreds of exhibitors products and

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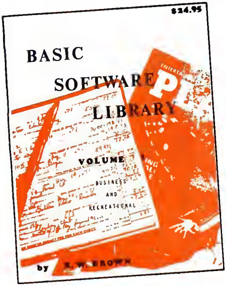

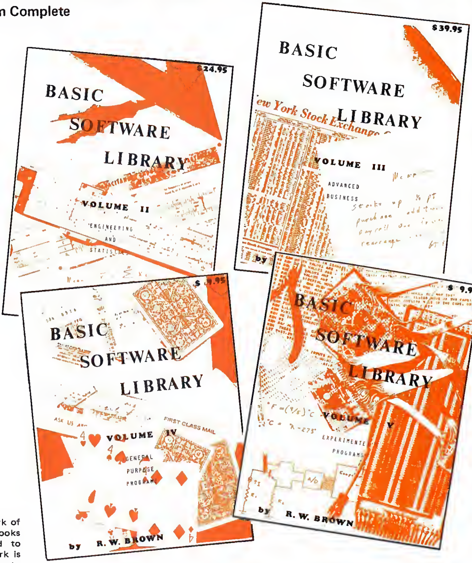

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This library is the most comprehensive work of its kind to date. There are other software books on the market but they are dedicated to computer games. The intention of this work is to allow the average individual the capability to easily perform useful and productive tasks with a computer. All of the programs contained within this Library have been thoroughly tested and executed on several systems. Included with each program is a description of the program, a list of potential users, instructions for execution and possible limitations that may arise when running it on various systems. Listed in the limitation section is the amount of memory that is required to store and execute the program.

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May 10-12 Chicagoland Business Services and Equipment Exposition at the Expocenter in Chicago IL. For more information contact: Carleton Rogers, Industrial and Scientific Conference Management Inc., 222 West Adams St., Chicago IL 60606. Or call (312) 391-9810.

May 11-15 Milan Italy. Computers, related equipment and systems exhibition at the U.S. Trade Center in Milan Italy.

May 16-20 London Great Britain. Telecommunication Equipment Exhibition at the U.S. Trade Center.

May 17-19 Nepcon East. Philadelphia Civic Center. Exhibitor Conferences and products will be featured. Call Frank L. Buccaro at (312) 263-4866 for more details.

May 24-26 Geneva Switzerland, International Microcomputers-Microprocessors '77.

May 28-29 Mid-America Computer Conference, Wichita KS. A hobbyist and small business forum and exhibits.

June 5-8 Chicago IL. Summer Consumer Electronics Show.

June 10-12 Computerfest '77 Cleveland OH. The second annual Computerfest 77 sponsored by the Midwest Affiliation of Computer Clubs Inc., will be held at the Bond Court Hotel, 777 St. Clair Ave., Cleveland OH. The ticket price of $2 will provide you with admission to seminars, technical sessions, flea market, and a manufacturers exhibit area. There will be prizes, games, and demonstrations. The show is open to all interested parties.

The Annual Club Congress of the Midwest Affiliation of Computer Clubs will be held at this event. This congress is open to all club members, trustees, and officers. For further information on the Computerfest send a stamped self-addressed envelope to MACC, P. O. Box 83, Brecksville OH 44141.

CALENDAR

May 4 New England Computer Society, Inc. will be meeting in the cafeteria of the Mitre Corp. at 7 PM. Located on Rte. 62, in Bedford, Ma. Contact Dave Day at (603) 434-4239 for details.

May 4 Northwest Computer Club will be meeting at 7 PM at the Pacific Science Center, Room 200, located on 2nd Av. in North Seattle WA 98109. A graphics show is scheduled for this month.

May 7 Louisville Area Computer Club meets at 1 PM in the Speed Auditorium at the University of Louisville, KY 40200. Details are available from Glenn Darwing at (502) 456-5589.

May 7 Ventura County Computer Society (SCCS) will meet at 7:30 PM at the Camarillo Public Library located at 3100 Ponderosa Dr., Camarillo CA. For more information write: VCCS, P.O. Box 525, Port Hueneme CA 93041 or call (805) 985-2631.

May 7 South Central Kansas Amateur Computer Association meets at 9 AM at 1430 E. Kellog in Wichita KS 67200. Call Cris Borger at (316) 265-1120 for details.

May 8 South Eastern Michigan Com-Computer Organization (SEMCO) will meet at 6 PM at the studios of WJBK-TV-2. Call President Dick Wier at 565-3228 for club agenda.

May 12 Rochester Area Microcomputer Society (RAMS) meets at the Rochester Institute of Technology, Bldg. 9, Room 1030 at 7:30 PM. For further details write RAMS, P.O. Box D, Rochester NY 14609.

May 13 Homebrew Computer Club meeting will begin at 7 PM in Menlo Park, CA at the Stanford Linear Accelerator Center Auditorium. Contact Bob Reiling at (415) 967-6754 for meeting details.

May 13 Crescent City Computer Club will meet at 8 PM at the University of New Orleans, Lakefront Campus. Call Bob Latham at (504) 722-6321 for club details.

May 13 Northern New Jersey Amateur Computer Club (NNJACC) will be meeting at the Fairleigh Dickinson University, Rutherford Campus, Becton Hall Room B8. For more information write to NNJACC, 593 New York Av., Lyndhurst NJ 07071.

May 14 Oklahoma Computer Club will be meeting at the Belle Isle Library at 10 AM. Call Al Campbell at (405) 842-4933 for the club agenda.

May 17 Rhode Island Computer Hobbyist (RICH) Club. Contact Roger Garrett at 16 Grinnell Street, Jamestown RI 02835 for meeting place and time.

May 19 New York Amateur Computer Club will meet at 7 PM. Call Bob Schwartz for meeting place at (212) 663-5549.

May 20 Long Island Computer Association meets at the New York Institute of Technology, Bldg. 500, Room 508 at 8 PM in Old Westbury NY 11803. Call (516) 938-6769 for further details.

May 21 South Central Kansas Amateur Computer Association will be meeting at 9 AM at 1430 E. Kellog in Wichita KS 67200. Call Cris Borger at (316) 265-1120 for club details.

May 22 Chicago Area Computer Hobbyist Exchange (CACHE) will meet at 12 PM in the cafeteria of the NIGAS Bldg. on Schermer Rd., Glenview IL. Call or write to CACHE, P.O. Box 36, Vernon Hills IL 60061 or (312) 620-1671.

May 24 Sacramento Microcomputer Users Group (SMUG) meeting will commence at 7:30 PM in the SMUG Training building on 59th Street between R and S streets. Write SMUG, P.O. Box 741, *Citrus Heights* CA 95610.

May 25 Northwest Computer Club meets at 7 PM in Room 200 at the Pacific Science Center in North Seattle WA 89109

May 25 Homebrew Computer Club meets at 7 PM at the Stanford Linear Accelerator Center Auditorium. Call Bob Reiling at (415) 967-6754 for details.

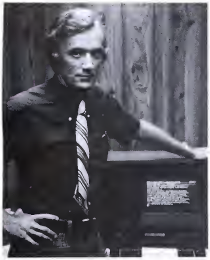
May 25 Ventura County Computer Society (VCCS-SCCS) will meet at 7:30 PM at the Camarillo Public Library located at 3100 Ponderosa Drive, Camarillo CA. For Club details write VCCS, P.O. Box 525, Port Hueneme, CA 93041 or call (805) 985-2631.

May 25 Diablo Professional Users Group will meet at 8 PM at the library conference room of the Diablo Valley College. For more information call Bob Hendrickson at (415) 687-8373.

May 26 Small Computer Engineering Association of Minnesota (SCEAM) will hold its meeting at 7 PM at 3010 4th Av., South Minneapolis, MN 55408 near Lake and Nicollet streets. Call (612) 824-6406 for more information.

SENSE LINE

Bill Sevedge



This column is the first in a series. It is designed to aid the many computer clubs, associations, and societies throughout the many countries in which INTERFACE AGE reaches. The 'Sense' line will research your operational problems, and attempt to give public advice to improve the situation. This advice or direction will be interfaced with a few convictions of my own. Reader response is welcome, as well as problems relating to your club. Be sure to include the club name, a person's name who is familiar with the problem and the phone number, so I can review the situation with them, and receive approval or disapproval to use the club name at the end of the case problem. In regards to a reader response, I will use only initials and city of origin when comments are used.

I'd like to begin this column with the subject of being positive. A positive attitude among the club officers and its members is part of what makes a club successful. On the other hand, a negative attitude results in dissension, low attendance at club meetings, and eventual club failure. How often have you heard these excerpts:

1. "I'm not going to bring my system. I've finally set it up, besides, everyone else will bring in theirs".
2. "If we don't get some support on this newsletter, we will be forced to discontinue it".
3. "Well does anyone have anything to share with us this month?"
4. "I'm not going to the meeting this month, it's always the same".

These are just a few of the examples of negative attitude. I'm sure you could add to the few examples I've given. The worst thing that could happen to a club is radiating a negative attitude, affecting both the club's officers and its members. The club officers should be the ones to alter this attitude. Keep the theme of the meetings positive. For example, No. 3, If you would try 'Well, if nobody has anything to contribute, we're going to . . .' and come up with a project that will keep the interest of the members. Newsletters reflect the attitude of your club to everyone on the mailing list, as well as other readers. This is the main item to keep positive. For example, 'We still have a little space of next month's issue', with 'little' as the key word to keep it positive.

Next month, I will relate a few ideas to make those meetings more positive by offering examples of variety.

. . . FROM THE FOUNTAINHEAD

By Adam Osborne

Now that the Intel 8085 and 8048 are here, IMSAI is going for these two products; IMSAI is not planning to offer a Z-80 CPU card. I wonder why the Z-80 and the Intel products have to be mutually exclusive?

I have had a chance to examine the 8085 and the 8048—and I believe some intriguing user patterns are likely to emerge.

Let us begin by comparing the 8085 with the Z-80, both of which purport to be the "next generation" 8080-A.

These are the two major faults of the 8080-A:

a) The 8080-A is really a three-chip CPU, consisting of the 8080-A CPU, the 8224 clock generator and the 8228 system bus controller.
b) The 8080-A requires three power supplies: +5V, +12V and -5V.

Both the 8085 and Z-80 have eliminated these two problems; CPU logic has been reduced to a single chip which requires a single +5V power supply.

Now to you as a hobbyist, these two 8080-A problems may seem a bit abstruse, but chips and power supplies both cost money; these two 8080-A problems have resulted in higher cost 8080-A CPU cards.

But while eliminating two problems, the 8085 seems to have introduced a new one — multiplexed data and address busses.

The 8085 instruction set is almost identical to that of the 8080-A; the 8085 has just two new instructions. The Z-80 instruction set, as all you hobbyists know, is about twice the size of the 8080-A instruction set. Instruction sets are very important to hobbyists, but not very important to large commercial users who often pay more attention to chip counts and part costs.

Along with its enhanced instruction set, the Z-80 contains additional registers within its CPU. The 8085 registers are identical to the 8080-A's.

The Z-80 provides logic to refresh dynamic memories which the 8085 does not do. What this means is that it is cheaper to interface large, low cost memories to a Z-80 than it is to an 8085.

The Z-80 has three modes in which its interrupt logic may operate, but it has just two interrupt request pins. The 8085 has five interrupt request pins, three of which generate their own dedicated Restart instructions.

The 8085 has a primitive serial input and output capability, which the Z-80 does not have.

Now we could go on comparing "features", since that is very subjective. More often than not advertised features are nothing short of marketing propaganda. In fact, I define a "feature" as a design error which the manufacturers could not get out in time, so they gave it to marketing to dress up as an asset.

But what is far more important is that I believe I can identify key aspects of the 8085 versus the Z-80 which are going to direct the two products into somewhat different markets.

The Z-80 has an instruction set which people who do much programming appreciate; it also has signals and internal characteristics which make it more attractive than the 8085 in large microcomputer systems. For example, dynamic memory is cheaper than static memory, but that only becomes a significant cost factor in large memories.

However, the 8085 has a secret trump card — at least for the moment — its support devices, the 8155, the 8355 and the 8755.

The 8155 provides 256 bytes of read/write memory, three I/O ports and a programmable time, all on a single chip. The 8355 provides 2048 bytes of ROM and two I/O ports, on a single chip. The 8755 is a variation of the 8355 having erasable PROM. Now you can put together some rather interesting two-chip and three-chip systems based on the 8085, the 8155, the 8355 and the 8755. Putting together similar systems using the Z-80 would require considerably more logic and expense. The 8155, 8355 and 8755 internally demultiplex the 8085 data and address busses which you must demultiplex externally if you're going to have larger 8085-based systems — at which time the Z-80 will generate lower chip counts and costs.

In summary, I believe the 8085 will have difficulty dislodging established Z-80 users, and there are many of them, particularly among hobbyists. The 8085 will also have a hard time competing with the Z-80 in large microcomputer systems, or programming intensive microcomputer applications. But the two-chip and three-chip 8085 configurations are going to look very attractive to commercial users who are interested in large volumes and low chip counts and cannot get by with the one-chip microcomputers now appearing on the market (the Fairchild 3859, the Mostek 3870 and the Intel 8048). Since hobbyists are not part of the high volume, price sensitive market, what this means is that the 8085 will be having a hard time competing with the Z-80 for new hobby market

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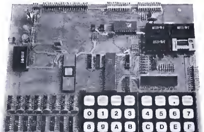
You can run almost any peripheral available. Not to mention the kids' electric train. The IMSAI Control Computer is



RS232 compatible. There are 12 quasi-bidirectional I/O lines with handshaking, and 14 more regular I/O lines, 5 heavy duty relays, and Teletype and audio cassette interfaces. All on one board.

There's already an extra 1K of RAM on board, plus sockets for another 1K of RAM and 2K of ROM/EROM. Still need more memory? The IMSAI 8048 allows expansion up to 64K of RAM off board.

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business. Of course, manufacturers now using the 8080-A will probably switch to the 8085.

But when will one of you hobbyists come up with a Z-80 assembler that uses 8080-A mnemonics?

What about the 8048? The 8048 is Intel's answer to the one-chip microcomputers being manufactured by Fairchild (the 3859) and Mostek (the 3870). IMSAI is the first manufacturer to produce an 8048 microcomputer card for the hobbyist. As a programmer you will find the 8048 highly restricting in its one-chip form. This one chip gives you a total of 64 bytes of data memory and 1024 bytes of program memory. The 8748 gives you an EPROM, but at a price which rivals a multichip Z-80 microcomputer configuration.

If you take the 8048 and expand it into a multichip microcomputer, with a quantity of external program memory and data memory, then you finish up with a microcomputer system that costs the same as a Z-80, or an 8085, but is much harder to use; and that makes no sense.

The 8048 is not really a programmer's product; it is not well suited to the average hobbyist's needs. But this is a microcomputer which you will love if you are building dedicated controllers. If you use microcomputers as instrument controllers in a laboratory, if you are a ham radio operator who wants to use microcomputers for dedicated control functions, even if you're running your model railroad at home with a microcomputer, then you will love the 8048 — or most specifically the 8748 for its simplicity and ease of configuration. If you are using the 8048 as a dedicated controller, you will likely want analog-to-digital and digital-to-analog converters. Check with Precision Monolithic Inc. (408-246-9222) for some interesting new one-chip A/D and D/A converters.

And now for a few tidbits from other manufacturers.

National Semiconductor has been amazed at the response the SC/MP keyboard kit system has generated among hobbyists. Apparently hobbyists account for the bulk of keyboard kit customers. National now has a 4K basic available for SC/MP; which they call "Nibble". But National does not yet have a real hobby microcomputer system. Despite rumors that National Semiconductor is imminently going to enter the hobby market, no decision to that effect has yet been made.

One of the most interesting chips due later this year is the 9511 arithmetic processing unit from Advanced Micro Devices. This chip will give microprocessors high speed arithmetic comparable to large minicomputers. The 9511 makes multidigit multiplication and division and floating point arithmetic cheap and practice. I predict it will be one of the hottest chips of 1978.

Two more hot tips: Gary Killdall, who goes by the name "Digital Research" and works in Monterey, California (408) 373-3403 produces the best software we have seen yet. Mr. Morro of Morro's Microstuff has been designing some very good S100 boards.

In my first article I explained that I had selected the name "From the Fountainhead" since the area from which I am reporting contains most of the manufacturers and important companies in the microcomputer industry. Manny Lemas of Microcomputer Associates was dismayed when his company and its products — the Jolt microcomputer system and "Microcomputer Digest" magazine — did not appear in my list of company names. I forgot to mention you Manny, so here is the mention.

And in case you want to be mentioned, either for your products or your opinion, please call me. My telephone number is (415) 548-2805.

COMPUTRAC

State-of-the-Art Century-old Record Newest Microprocessor

by Robert Cheeseboro

Mechanisms for playing records have been around for 100 years or so, and until recently, have performed the limited function of playing the record from beginning to end. The only fundamental improvements in phonograph design made during that time were the addition of automatic set-down and lift of the tone-arm, and the development of the automatic changer mechanism for stacked records. Of course, there has been a tremendous advance in tone-arm pick-up technology, in particular, the introduction of the magnetic-coil transducer cartridge.

Nevertheless, the phonograph turntable as we have known it through the years has, with few notable exceptions, remained basically the same and has not kept adequate pace with the dramatic improvements which have been made in phonograph record technology. Modern disc records only remotely resemble their earlier ancestors, even those produced as recently as 20 years ago. Vastly improved vinyl materials and compounds used in the manufacture of today's phonograph records make possible extremely low-noise, high-signal recordings with extended play life and anti-warp characteristics. In addition, the development of the "micro-groove" cutting process allows for extremely high groove packing density per radial inch, which translates into longer play time per side (in excess of 20 minutes) if desired by the recording studio programmer. Lastly, the newly-developed vinyl materials with their high-resolution replication properties make possible the 45,000 Hz carrier frequencies required for high-fidelity 2- and 4-channel stereo recordings which are in mass-production today.

Within the past two years, however, a quiet but dramatic revolution in record player design has started to unfold, in most part initiated by relative newcomers into the ranks of the phonograph equipment manufacturers; Cheeseboro Products Corporation is one such innovative new company. The two most significant of these design advances are straight-line tangential tracking and the servo-controlled direct-drive turntable.

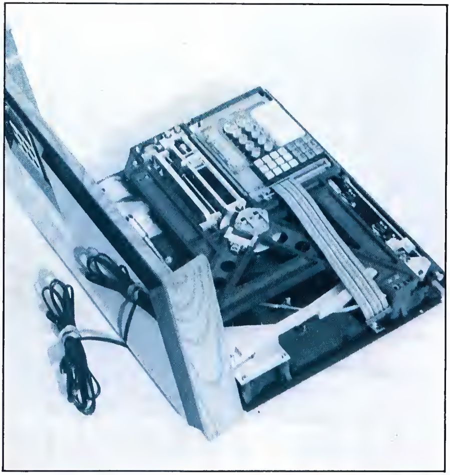
2000

Marriage of Player Market to Technology

The quantum jumps made during the past decade in electronic solid-state control technology made the direct-drive turntable motor a reality, since such a motor needs a servo-control system in order to maintain the constant speed required by the rotating disc record. Extremely fine speed control of the turntable is essential in order to reproduce the very high-fidelity recordings made today, and the direct-drive turntable eliminates the use of drive belts and speed reducers which cause rumble, speed error, and wow and flutter. Such disturbances are easily detectable when reproduced on today's expensive, high-resolution amplifiers and speaker systems.

Within the past years a quiet revolution in record player design has taken place: straight-line tangential tracking, servo-controlled turntable and now microprocessor-controlled pin-pointing.

The recent introduction of straight-line, tangential-tracking record players, specifically those marketed by Bang & Olufsen (B & O) and Harman-Kardon (Rabco), addresses the other principal deficiency of older standard record players. This concerns the anomaly of a horizontally-pivoted, 8- to 12-inch long tone-arm attempting to reproduce faithfully music information originally recorded in a straight line by the cutting lathe to the center of the master record. Since the standard pivoted tone-arm describes an arc as it traverses the record, the sound reproduced thereby is a distortion of the original recording. This is the "tracking error"—lack of tangency to the record groove—caused by the arc of travel of the pick-up needle to the center of the record.



The servo-driven tangential-tracking tone-arm phonograph players marketed by B & O and Rabco do indeed tend to correct the horizontal tracking error problem (though both units depend upon a slight arc of horizontal tone-arm movement to activate the servo drive), but they also create many other problems and reliability considerations because of their complexity. So, though these straight-line tracking units substantially eliminate the horizontal tracking-error problems, the fact that they still employ a lengthy tone-arm causes them to retain many of the deficiencies of the standard tone-arm, such as vertical tracking angle error, tone-arm resonance, excessive tone-arm mass to tracking force ratio, and the need for massive counterweights in an attempt to counterbalance the heavy tone-arm weight. In addition, *all* of the present units, both standard and servo-driven tone-arm types, leave the ever-more-delicate tone-arm and pick-up cartridge needle exposed to inevitable damage by the user, as well as damage caused by exposure to dust and other uncontrollable contaminants and damage.

The development of the **COMPUTRAC 2000** by Cheeseboro Products Corporation comes as a result of an intensive 15-year effort to remedy the problems associated with standard record players, during which time we introduced the SWINGER STEREO 70, which featured a free-floating, fully compliant radial-tracking pick-up cartridge system, all housed in a compact, totally enclosed housing, capable of operation in the vertical as well as horizontal positions. The **COMPUTRAC 2000** not only eliminates mechanical problems, but advances the state-of-the-art in such devices considerably beyond the simple record-playing function and into the realm of random programming, an essential requirement for the creative end of today's music and broadcast industries, as well as providing home entertainment versatility for the enjoyment of the consumer.

This programming capability is made possible by the application of the microprocessor in combination with the radial-tracking mechanism in the patented design. The ability to access rapidly across the surface of the record disc in a pre-determined and precise fashion opens a whole new world of uses for the record player which were not possible as long as record players were confined to the simplistic play-only modes.

The microprocessor-programmable control arrangement of the **COMPUTRAC 2000** gives the user operating choices during play of the record that were previously unavailable, and full control over which passages or portions of passages on a record to be played, and in any sequence desired. This design enables the user to select the precise beginning and ending points of a recorded passage (or portions thereof) of interest, to program the player to repeat the selected passage any number of times desired, and to play the desired passages in any sequence desired, even sequences different from the sequence defined in the phonograph record.

The microprocessor enables the user to make playing choices on his record in whatever sequence and repeat these sequences as desired

Commands for such operations may be entered into the record player manually by the user at the time of playing of a particular record, or the necessary commands may be recorded on the label of the record itself for use later when it is actually desired to play the record. The latter feature is potentially of great benefit to radio stations, recording studios, music composers, programmed learning, dance studios and discotheques, as well as ordinary home users who desire to program the playback sequence on their records. It is anticipated that, if adopted by record producers, the inclusion of pre-recorded position information on the record label will vastly simplify the tasks of playback programming by the many users listed above, and also will make possible the automation of many more record players in the future. It should be noted, at this point, that there has been one notable record player introduced into the marketplace which allows pre-programming of passages on a record during play: the **ACCUTRAC** by ADC. However, the ACCUTRAC has limited programming capacity and can program full recorded selections only, since it works on the principle of a light source and detector finding the smooth spaces (or lands) between the recorded passages. Hence, the programming of the ACCUTRAC essentially directs the detector to "count" the lands and to play the passages of interest, in the randomized sequence entered into the memory.

On the other hand, the **COMPUTRAC 2000** does not depend on a light-detecting principle which relies on scanning the record during play, rather makes full use of the capabilities of the microprocessor to handle the inputs of real-time pick-up position data and its ability to store and organize that data, as well as its capacity simultaneously to accept the input of digital data from the control keyboard. In particular, the micro-computer in the **COMPUTRAC 2000** knows *at all times* where the pick-up needle is in relation to its starting and stopping point. This is accomplished by the use of a servo-driven pick-up cartridge "follower" mechanism assembly, which will be discussed later.

As mentioned previously, the **COMPUTRAC 2000** makes possible unique programming sequences, such as for example those desirable for use by radio station personnel. Existing radio station audio programming equipment requires multiple operating modes and have controls which at first appear complex. In broadcast studios under the pressure of real-time conditions associated with live radio or television broadcasts, the workload on a studio technician can be very high. The **COMPUTRAC 2000** uses dual interlocking approaches, made possible by the application of the microprocessor, to alleviate this workload. The selection and scheduling chores, i.e., the decisions as to which passages or portions of passages to play from various records, can be performed in advance of the actual broadcast. Next, the microprocessor handles much of the operational logic and decision-making process by, in effect, instructing the user to do first this and then do that. Passage selection, either from a multiband phonograph record or of a selected portion from a single-band recording such as a symphony, can be predetermined precisely by reference to the digital display and readout on the control panel which, through the radial-tracking "follower" mechanism in the record player, displays the position of the pick-up needle on the record with an accuracy of about 0.02 millimeter, which is about the width of a record groove. Programming instructions peculiar to a given record can be encoded on the record itself, in a form which can be changed at a later time, through the medium of the annular magnetic tape which can be adhesively affixed to the record by the user, or provided by the record manufacturer.

Space does not permit a detailed description of the many other features and functions of the **COMPUTRAC 2000** in addition to the very impor-

tant position control feature described in the foregoing. However, we will list them briefly, and call attention to the detail of the control panel for the specific location of the corresponding pushbuttons which initiate these additional features. (Figure 1)

* Powered record loading
* 7, 10, or 12-inch record size automatically selected
* Push-button selection of 33 or 45 RPM turntable speed, which causes servo control of the direct-drive motor.
* Single or continuous record playing mode
* Fast forward and reverse pick-up cartridge movement (stepper motor slews in either direction at 500 pulses/second)
* Powered pause
* LED display of Time-of-day, Elapsed time, Pick-up needle position, Turntable rotational speed, and Program data stored in memory.
* Full micro-computer control of all functions of the record player memories
* Control of remote devices (tape unit, amplifier, etc.) by use of remote terminals in rear of unit.

The basic element of the overall control system is the central processor unit, an INTEL 8080 with an internal clock circuit module and a control module. The control module is an INTEL 8228 IC, (see Figure 4 and subsequent schematics).

The ROM and RAM units shown in Figure 3 each have 8K of memory capacity. The ROM controls the interlock between lift solenoid and stepper in its high speed mode to traverse the cartridge and stylus in a lifted position above the record to a new designated position. The ROM also controls the L.E.D.'s. The RAM serves as the data storage bank for playback programming.

Apart from numbers storage and processing, the micro-computer within the **COMPUTRAC 2000** also handles logic functions through a ROM associated with the microprocessor. The effect, from the point of view of the user, is an optical "guided tour" through what essentially is an operating manual for the record player. This is accomplished through the medium of lighted pushbuttons and other controls on the control panel. Improper commands entered into the unit by the user are defeated, and the next proper command is indicated as the appropriate control pushbutton is illuminated in the proper sequence. It should be evident, however, that a user of the **COMPUTRAC 2000** may choose to ignore the various control options possible, and employ only three or so of the

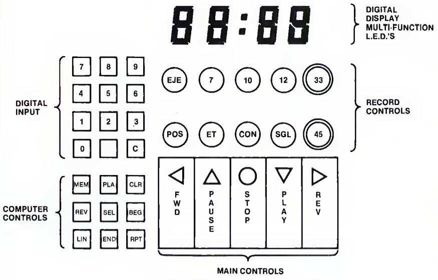


Figure 1. Control Panel

Instruction set

Record controls
EJE: Causes record loading door to open, lifts pickup.
7, 10, 12: Determines positioning of arms on record loading door for 7-inch, 10-inch, 12-inch records.
33, 45: Determines turntable speed. Both knobs have fine-tuning rings. Speed is shown by LEDs (e.g. 33.33)
POS: Shows needle position in mm from ending position. Count starts at 96.00, is shown by LEDs.
ET: LEDs show elapsed playing time in minutes and seconds.
CON: Replays record continuously until STOP button is actuated.
SGL: Shuts off player after one side of record.
Main controls
FWD: Lifts cartridge, traverses toward center of record. Play resumes when button is released.
PAUSE: Lifts pickup cartridge, stops position count, stops time accumulation, enables memory for programming.
STOP: Lifts pickup cartridge, reverses turntable motor, lowers turntable, shuts off motor. LEDs display hours, minutes and (with flashing colon) seconds.
PLAY: Loading door closes; turntable lifts record and rotates; record plays as instructed.
REV: Lifts pickup, traverses toward starting position. Play resumes when button is released.
Computer controls
MEM: Activates write head for recording onto magnetic track on record.
PLA: Enables programming of play sequence.
CLR: Clears display digits.
SEL: Designates selection of interest. User enters number (see POS) on digital input section.
BEG: Beginning of selected passage. User enters position information.
END: End of selected passage. User enters position (manually, or automatically from POS reading).
RPT: User enters number of times passage is to be repeated.
REV: Recalls, displays either MEM recorded program or PLA recorded program. Changes in program can be made while REV is on.
LIN: Program is displayed line after line. Allows user to locate spot in program for re-recording.
Digital input
0 - 9: input buttons
C: Correction
Multi-function LED display
Unless otherwise used as indicated above (position, elapsed playing time), shows time of day when STOP is depressed, or player is not on; stops time display when EJE is depressed.

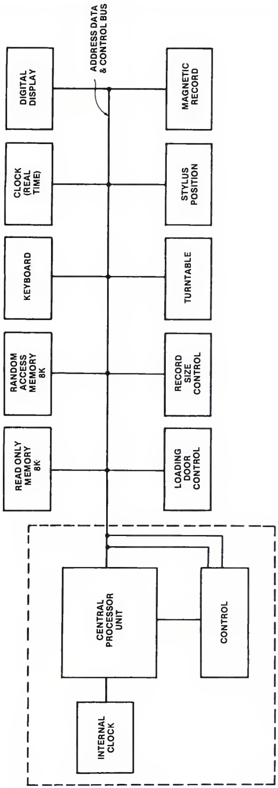


Figure 3. Control System.

main controls to operate the record player in a less sophisticated manner. And when required, potentially complex programming operations are simplified by the functional organization of the control pushbuttons on the control panel. If, for example, a recorded sound background to be used in a radio broadcast is required to end precisely with the last word of a spoken passage by an announcer, the microprocessor can be programmed to start the recorded passage precisely at the point desired by the user on the record of interest.

The pick-up cartridge "follower" assembly referred to above is the key to the positioning data input for the microprocessor, as well as the mechanism for positioning the pick-up cartridge in response to the pre-programmed sequenced desired by the user. The follower assembly is located in relation to the pick-up cartridge so that it moves along a path parallel to the travel of the needle as it tracks radially to the center of the record. The "follower" does not touch the pick-up cartridge during normal operation, but lifts the pick-up during pause, and carries the pick-up at high speed during fast forward or reverse operations. The follower contains a light source and two photodetectors which sense the movement of the pick-up cartridge as it travels across the record during play, and, through a servo-controlled stepper motor which drives the "follower's" lead-screw, always tends to the "null" or "zero" position in relation to the centerline of the pick-up needle. The logic and memory sections of the micro-computer in the record player control system includes a counter in which is accumulated a count of the pulses operating the stepper motor driving the "follower" member from any given position along its path of movement parallel to the pick-up cartridge back to its starting position.

The COMPUTRAC 2000 represents a significant advance in the state-of-the-art in record players and opens the door for development of automated library systems.

It is this count which is actually assigned to memory when the microprocessor in the record player is programmed to determine the manner and sequence in which a given record is to be played. A position pushbutton (POS) on the control panel causes the count, in millimeters from the starting position, to be displayed on the 4-digit LED display panel. (Figure 2—a and b)

The **COMPUTRAC 2000**, therefore, represents a significant advance in the state-of-the-art of record players, and is the pre-cursor of even more dramatic possibilities in record playback mechanisms. These include an Automated Home Record Library, which would store hundreds of records in a dust-free enclosure which would play records in response to the user demand. The **COMPUTRAC 2000** can be utilized with built in video display of the functions in operation, for O.E.M. applications in furniture, teaching systems, computer systems, shipboard and airborne sound systems; video-disc applications for inexpensive audio and visual playback units; as well as other unknown applications. The totally-enclosed design and functionally pure shape of the **COMPUTRAC 2000** opens a whole new era of concepts in styling freedom, allowing the unit to establish standards indicative of the future of the record player mechanisms yet to be designed.

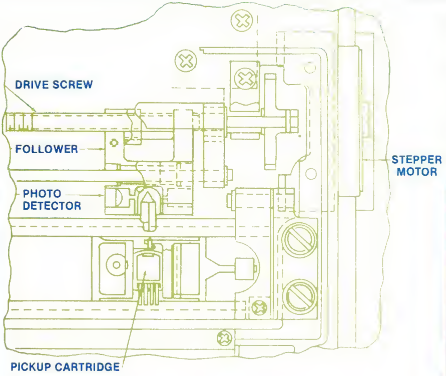


Figure 2b. Cartridge and Follower — Topview

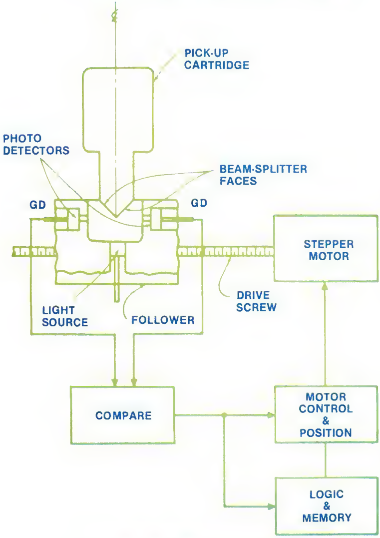


Figure 2a. Cartridge Follower Control Circuit

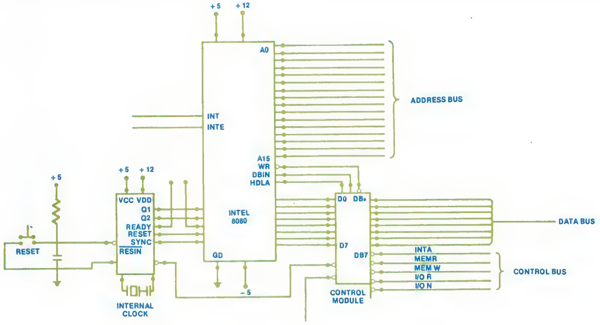


Figure 4. Central Processor

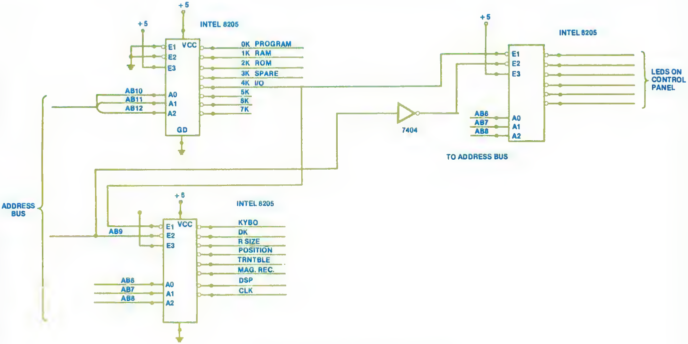


Figure 5. Address Decode Sub-System

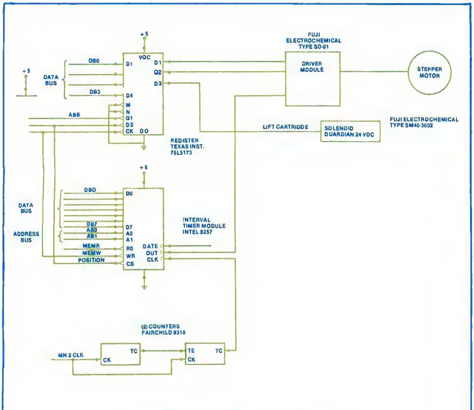


Figure 6. Stylus Position Sub-System

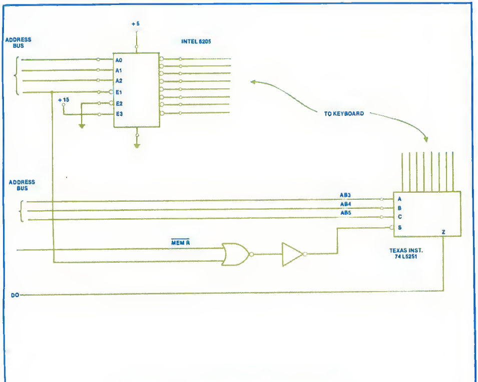


Figure 7. Keyboard Scan Sub-System.

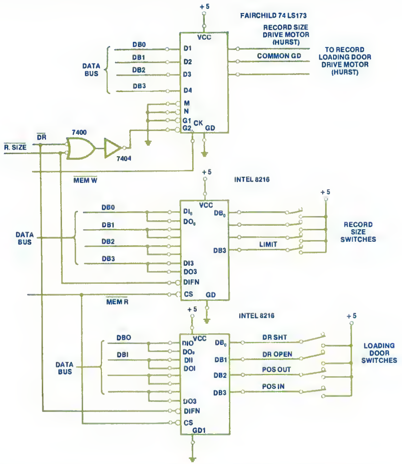


Figure 8. Record Loading Door And Record Size Control Sub-System.

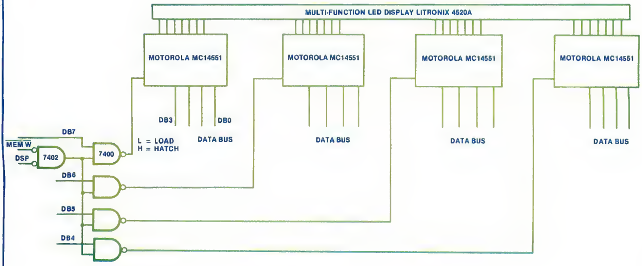


Figure 9. Digital Display Drive Sub-System

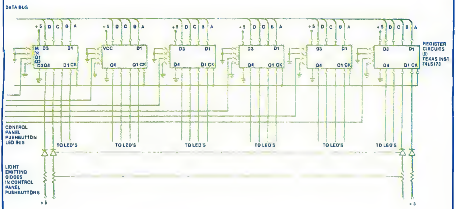


Figure 10. Control Panel Lighting Sub-System

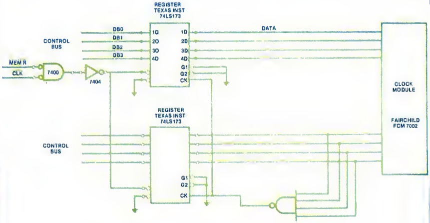


Figure 11. Real-Time Clock Sub-System

Editorial

THE FLOPPY-ROM™ EXPERIMENT

—Or the Joy of Developing a Simple Idea

by Robert S. Jones, Publisher

Seldom does one have the chance to participate in a new and exciting event which could initiate a programming revolution.

The Floppy-ROM™ has just such a potential.

With great pride INTERFACE AGE Magazine presents this pioneering special feature in this issue. We invite our colleagues in the publishing field to join with us in providing our combined readership with this important advantage of mass-distributed software.

Our plans for the future call for more Floppy-ROMs™ supporting the 8080, Z-80 and 6502 CPUs.

It would be a pleasure to say that it was our idea, but unfortunately we cannot take that credit. Neither was it developed nor debugged by us. And in that point lies the real story.

This event is the achievement of many manufacturers and retail computer stores who have worked together on this project.

The story began at the Personal Computing '76 Trade Fair at Atlantic City, NJ when Bob Marsh of Processor Technology Corp. proposed the idea of pressing software onto a vinyl record. (We are including a milestone chart in Figure 1 to outline the events leading up the present success.)

Processor Technology provided a test 8080 program which was recorded on a master disc. Unfortunately it did not work when tested. The designers at that time were unable to devote further development to the project.

Southwest Technical Products and Technical Design Labs were then contacted and positive commitments resulted.

Dan Meyer and Gary Kay of SWTPC co-ordinated the participation of Robert Uiterwyk, Software Consultant to much of the industry.

At this point activity split. The record manufacturer, EVA-TONE of Deerfield, IL, pursued an independent research to improve the recording technique. Ethan Lazar and Perry Farazi of Itty Bitty Machine Co. in Evanston, IL played a major role with EVA-TONE in producing four TV games on a record as a test which was later refined into a recording technique by the engineering personnel from Heath Co., Benton Harbor, MI. They brought their system into EVA-TONE's facility and worked directly with the recording engineers. The third record was cut with excellent results.

While this was taking place at EVA-TONE, Robert Uiterwyk, consultant Bill Turner and Bill Blomgren of MicroComputer Systems, Inc., Tampa, FL were preparing the final program and documentation which appear in this issue. These gentlemen worked many long hours in co-ordinating, developing and evaluating the pre-production test data.

Our thanks to Bruce Van Natta and Mike Stone, marketing manager of IMSAI; Dan Meyer and Gary Kay of SWTPC who co-ordinated Robert Uiterwyk's work; to Tom Durston and Ed Roberts, president of MITS, for all their valuable assistance and input in the pre-production testing stage of the Floppy-ROM™.

MITS plans to publish a loader in "Computer Notes" which will allow all 680 owners to use this Floppy-ROM™.

Our special thanks goes to Carl Evans of EVA-TONE whose patience and steadfast support made the Floppy-ROM™ a reality.

Our plans for the future call for more Floppy-ROMs™ supporting the 8080, Z-80 and 6502 CPUs.

In order to continue this program, we ask for your response to the questions listed below for you are the key to its success.

Please send your responses and any comments as soon as possible to: **Floppy-ROM™**, INTERFACE AGE Magazine, P.O. Box 1234, Cerritos, CA 90701.

SURVEY

QUESTIONS

1. Did your magazine with the Floppy-ROM™ arrive in good condition via the Post Office?
2. What kind of record player did you use? Approximate cost?
3. What type of cartridge is on your turntable, magnetic or ceramic? If you know, tell us the brand and model.
4. What model cassette interface did you use?
5. Whose 6800 system did you use? Tell us the manufacturer's name, not your friend's.
6. What is the memory size of the 6800 system and what peripheral do you have?
7. Did you have trouble loading the record?
8. How many times did you have to try loading before you were successful?
9. Did you have any difficulties that prevented it from operating at all? If so, what were they?
10. Did you load the computer directly from the record through the interface?
11. Did you record on cassette and from there to the computer? What happened?
12. What kind of tone control settings did you use and were they critical?
13. Was the playback level critical?
14. Did you play it back in monaural or stereo?
15. Do you like the Floppy-ROM™ concept?
16. What kinds of programs would you like to see in the future?

See page 83 for the Milestone Chart on the development of the Floppy-ROM™

PLATTER BASIC

The Search for a Good, Random Access, Record Cutting Juke Box

by William Blomgren

WHY "PLATTER BASIC" ON A FLOPPY-ROM™?

This is really a two-part question. First, why BASIC at all? The need for high level software is fairly self-evident, and BASIC will be explained in a second article later in this issue. For now, let's just settle with "Why a floppy-ROM™ or platter?"

Low cost software distribution is a recurring problem. It just appears that "low cost" and "high reliability" just don't seem to mix. Shipping programs in ROM, at several dollars per copy, is too expensive. All magnetic media cost too much, are fairly bulky, and are fragile. Machine readable print requires a fair amount of hardware. The bar code reader that we have located costs well over $100. Most people do not have a bar code reader, nor even access to one, but many do have some sort of record player. A conventional record costs a fair amount, and is relatively fragile. The "sound Sheet" or floppy-ROM contained in this issue is low in cost, and best of all, requires little more than a record player and your cassette interface.

WHAT'S ON THE RECORD?

There are two different sections on the record. First are the test patterns to align your cassette interface. The second section is the software you will want to load into your 6800 based microcomputer. This section of the record includes a binary loader program, and the binary dump of BASIC.

WHAT WILL I NEED TO USE THE RECORD?

A 6800 based microprocessor system is a must. A minimum amount of memory considered should be 6K. In addition, a Kansas City Cassette interface is also a must, and some sort of 300-baud terminal is desirable to check the alignment of your cassette interface. A cassette machine should be used to save BASIC once it gets loaded, because the record will have limited life. Don't rely on it for more than ten or twenty loads because it will wear out. Basic assumes that MIKBUG is resident in your system, with a scratchpad from A000 to A07F. Patching instructions are provided in an appendix to this article for those systems that do not have MIKBUG and the scratchpad. A separate loader program is also supplied for those without a MIKBUG loader. Several SWTPC 6800 systems have been used by various individuals in verifying the concept behind BASIC on a "floppy-ROM", so owners of those systems should not have any trouble at all. Last but certainly not least, a 33-1/3 RPM (*Roms Per Magazine . . .* or is it revolutions per minute???) turntable.

HOW WAS THE PLATTER MADE?

This section was not designed to be a discussion of how to cut a record, rather is a bit of history describing the path that BASIC took finding its way into INTERFACE AGE. This is not the whole path either, but just the side trip it took through MicroComputer Systems, Inc. to generate the record.

In late February the disc project was mentioned to me, and I approved. This was later followed by the request "Dump a copy of version-2 4K BASIC on a reel-to-reel." I grabbed a machine, and recorded the dump in Motorola MIKBUG format. This hexidecimal checksum dump took seven-and-a-half minutes. I found out an hour later, that there was a 6½ minute time limit. *Back to the old drawing board...*

I gathered together a test pattern routine, and a binary dump and load routine, recorded them on tape, and sent them to EVA-TONE. Naturally, Murphy's First Law of Shipper-Smashing held true. The reel of tape arrived in seven pieces. The people at EVA-TONE managed to salvage the tape, however, and cut a sample disk. The test patterns looked great, but there was a drop out in the middle of the loader. It was a non-recoverable fault, so again I went through the entire procedure. The record worked well the second time. Level and tone settings however, were very critical. Carl Evans at EVA-TONE suggested a direct dump from the computer into their cutting equipment. *Back again to the old drawing board.*

I rewrote the machine code that generated the test patterns and dumped BASIC, so that they would need no operator assistance. I shipped a program tape off to Illinois. A computer store in that area provided the use of a Southwest Technical Products 6800 computer, and the dump was on. I received a telephone call asking how to use my dumping routine — I told them to just load it and type 'G'. Sure enough, Lady Luck was now on my side; it worked. Elimination of the intermediary tape stage was very important; they managed to do a direct dump into the cutting equipment with perfect results. A one-to-two DB variation was noted in the tapes I sent them, and this would present problems to many people. The direct dump eliminated this entirely.

The masters have traveled across the entire country several times, and final approval was finally made for production. The production pressings worked and the end result is here in INTERFACE AGE.

WHAT IS THE "KANSAS CITY STANDARD?"

The "Kansas City" recording standard was established to allow interchange of data and programs between microcomputer users. It allows great latitude in playback speed, and can be used with almost any cassette

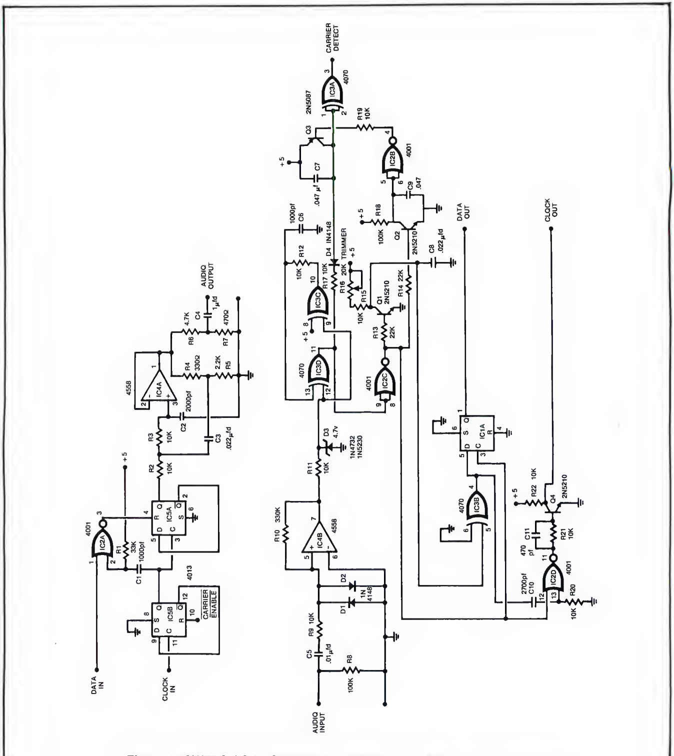


Figure 1. SWTPC AC-30 Cassette Tape Modulator/Demodulator Schematic

machine. "Marks", or logic ones, are represented by a frequency of 2400 Hz, and "spaces", or logic zeros, are represented by 1200 Hz. Data is transferred using the standard UART format, (1 start bit, 1 stop bit) at 300 baud. (Roughly thirty characters per second.) These frequencies were chosen because the 16X clock for the UART can be easily derived from the data being fed into the interface. Speed tolerances of 20- to 30% are acceptable. Figure 1 shows the circuit of the Southwest Technical Products AC-30. It is a fairly simple circuit, which will allow entry of the program into your system. With this circuit, or its equivalent, the program on the "floppy-ROM" may be read.

HOW DOES IT WORK?

Audio is fed through the highpass filter made up of R9 and C5. It is clipped by the pair of diodes, and fed into IC-4B, which acts as a comparator. IC-4 should be fed a well regulated 7.5V supply, to ensure stable operation at this point. Zener diode D3 limits the output of IC-4 to levels acceptable to the CMOS gate that follows. When the comparator changes state, IC-3C and IC-3D generate a short (5 microsecond) negative pulse. When data is being received, these pulses repeat. This train of negative pulses grounds C7 through D4. The output of C7 is inverted, buffered, and can be used to generate a carrier detect signal. These negative pulses are found at pin 11 of IC-3D. They're inverted by IC-2A, where they

feed four circuits. The first circuit is a missing pulse detector, made up of Q2 and IC-2B. They pull the Carrier detect signal low if several cycles of audio are lost.

The second circuit is an adjustable missing pulse detector, which "times out" when 1200 Hz data are received. R16 trims this time period. The third circuit is flip-flop IC-1A, which outputs the data. Its output is high when 1200 Hz is received. The last circuit is the clock synthesizer, which is made up of IC-2D and IC-3B. These generate the 16X clock for your UART.

HOW DO I HOOK UP A TURNTABLE?

The AC-30 requires about 5 volts of signal to decode the data on the floppy record. Speaker output jacks will easily supply this level. Before you hook up Junior's phonograph, check to see if it has a transformer - isolated chassis. If it doesn't, *don't hook it up!* It would be all too easy to get 120V of your local power utility into your computer. This would tend to make a very expensive pile of write-only memory. If necessary, have a technician check out your stereo. Some component pre-amps are capable of driving 5 volts. A Dyna Pat-4 was used to test the records, and that worked nicely. However, it had to be turned up all the way. If your stereo set has a MONO-STEREO switch, set it on mono. A large percentage of noise on this type of disc is vertical. The vertical signal is essentially a "difference" signal for stereo, but is unwanted for this playback. It will cancel nicely, which will help load a very noisy disc.

Adjust your stereo set for 'flat' response. If your tone control is a 'High Cut' type, set the control for maximum. This is the starting point to align your system. If possible, transcribe the record the first time it is played. It should have reasonable life, 20 to 30 plays or more, but better safe than sorry.

WHAT ARE THE WEIRD SIGNALS AT THE START OF THE RECORD?

There are two test patterns that should be used to set up your AC-30. The first is a pattern of "5"s. Set your system up to echo the data from the tape to your terminal (local mode). Play back the tape. You should see a stream of "5"s. If you don't, adjust the tone and volume controls slowly and carefully. The "5"s should play back perfectly. There should be no other characters intermixed with the "5"s.

If you are not able to get the "5"s to play back properly, check your interface circuitry next. If you built the interface shown in Figure 1, adjust the R16 to trim the test pattern.

The second test pattern is a "U*" pattern, to check for jitter. If the "5"s worked properly, this should also. If you are not able to get the "5"s to read out, don't go further. Examine your connections, make sure you do not have any ground loops. Make sure you are getting a good clean signal out of the turntable. If you re-recorded the record on a cassette, make sure that you did not overload the cassette recorder when recording. Figure 2 shows a general view of how your system should be hooked up, with the turntable hooked into the AC-30 in place of a cassette machine. If you have arrived this far with flying colors, now is the time to load the program. First check your memory. Make sure all is well before going much further.

On March 26 we received the first sample run of floppy-ROMs. I had problems loading, until I found out someone had borrowed my low memory card. Memory from 0000 to 0FFF is a must! I set up my levels and the test pattern was good. A slightly high boost may be necessary in some systems. If your system has a rumble filter, switch it on. There will be no valid information below 100 Hz, and elimination of these noise components may be helpful.

If your record player has a good "scratch" filter, try it too. There is no information above 2400, but response at 2400 should be left as "Flat" as possible. If your scratch filter affects 5000 and above, it may be OK; 10000 and above would be better. Remember that most filters have a finite slope and frequencies 2 to 3 octaves away from the break frequency will be affected by level and phase changes. If you detect errors during program load, turn off the 'scratch' filter first.

WHAT IF MY TURNTABLE RUNS FAST OR SLOWLY?

Again, the beauty of the "Kansas City" standard comes to the rescue. Very few turntables have speed errors larger than 10%, so there is little reason for concern. If your error is very large, adjust your cassette interface card. I ran my turntable from 10% slow to 10% fast; 10% slow required a slight AC-30 'tweak', while 10% fast did not. Run as close to 33-1/3 as possible on an adjustable speed turntable.

HOW DO I LOAD THE PROGRAM?

After the test patterns, there is a 20-second space where the 'band' is cut. A string of 'L's follow, to start the loader function in MIKBUG. Place your tone arm down on the record near the end of the test patterns. There is a binary loader program in front of the data, which MIKBUG loads into memory at 1100 HEX. The computer then executes the binary load program, and loads BASIC. Very simple if you have MIKBUG. If you don't, I would recommend either patching the loader program, or re-assembling it as necessary. Figure 4 is a listing of the loader program which was loaded at 1100 HEX. You will note several MIKBUG routines were used. Patch these to fit your operating system. If your turntable has a center depression, place a regular record on the turntable first to support the floppy-ROM.

WHICH MACHINES CAN USE 4K BASIC?

No 8080 based system will run this program. So IMSAI, Processor Tech, Altair 8080, DG 8080, 6502 and Z80 systems need not try.

The software will run only on a 6800 CPU, but this still becomes a fairly touchy question. I will tell you what I believe: the skill of the individual will tell what is really possible, and what is not. SWTPC 6800 owners should have no trouble at all if 6K of memory is present in the system. The MITS 680 will run the program with modifications. It will also require much more memory than is resident in the basic system. Several articles have been written on expanding the basic chassis. Expand and enjoy. You may need to supply a cassette interface as well. The schematic in Figure 1 should do well. You will need a block of memory from 0000 to at least 1200 HEX.

The Digital Group 6800 system will run the program, but you will need to completely re-do their cassette interface. In addition, you will have to supply several subroutines to operate BASIC. The memory that is standard with the DG should be adequate for 4K BASIC.

The Motorola evaluation module will run this program, but will need more memory. Their new evaluation module with the 'JBUG' monitor will require patching, but older MIKBUG equipped systems will run *as is.*

I don't have enough information on the Sphere 6800 system to predict success or failure. Operation in that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PROGRAM SHEET
33 1/3 RPM
MONAURAL
PLACE COIN HERE IF SOUNDSHEET SLIPS
6800 4K BASIC
Composed by
Robert Uiterwyk
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VOL. 2, ISSUE 6
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MAY, 1977
3177
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system has occurred, but will probably require extensive patching to BASIC.

This program will run in the OSI, but will require much patching. You will have to supply a loader program, and patch the I/O. Also, two routines in MIKBUG that are not in their ROM will have to be patched in. In addition, a cassette interface that is "Kansas City" standard may have to be supplied. Run and Enjoy!

This program should run in a Jupiter II, but I have insufficient data to predict success or failure. Much software may have to be written to drive their CRT interface. Good luck.

Owners of Motorola Exorcisors can run this program with relative ease. Some patches will be required.

The AMI EVK evaluation modules will run this BASIC, but will require patcning. It will also need 6K of memory.

Other 6800 systems may be able to run this program. The memory map outlines memory usage. If you have RAM at the appropriate points, the system should go.

Memory Map for 4K Basic

0000-00FF	Input buffer and temporary variable storage
0100	Hard starting address of Basic (Cold start — clears program)
0103	Soft starting address of Basic (warm start — saves program)
0105-10FF	Basic Interpreter
1100-11FF	Arithmetic and For-Next stack
A000-A045	Machine stack
A04A-A07F	Index register stack

Note: Binary loader program starts at 1100. It will be cleared by the Basic interpreter when 0100 is executed.

BILOAD PROGRAM

```
1100                 ORG      $1100
1100 8E A047 BILOAD  LDS      #$A047
1103 8D 49           BSR      LOAD

1105 8D 3C   OVER    BSR      INPUT
1107 81 58           CMP A    #'X
1109 26 FA           BNE      OVER
110B 8D 36           BSR      INPUT
110D 81 31           CMP A    #'1
110F 27 07           BEQ      READ
1111 81 39           CMP A    #'9
1113 26 F0           BNE      OVER
1115 7E E0E3         JMP      CONTRL


1118 7F A016 READ    CLR      CKSM
111B 8D 26           BSR      INPUT
111D 16              TAB
111E 5C              INC B
111F 8D 22           BSR      INPUT
1121 B7 A019         STA A    TW
1124 8D 1D           BSR      INPUT
1126 B7 A01A         STA A    TW+1
1129 FE A019         LDX      TW


112C 8D 15   STORE   BSR      INPUT
112E A7 00           STA A    X
1130 01              NOP
1131 A1 00           CMP A    X
1133 26 0B           BNE      OUT
1135 08              INX
1136 5A              DEC B
1137 26 F3           BNE      STORE
1139 8D 08           BSR      INPUT
113B 7C A016         INC      CKSM
113E 27 C5           BEQ      OVER


1140 7E E040 OUT     JMP      LOAD19

1143 8D 14   INPUT   BSR      INCHP
1145 36              PSH A
1146 BB A016         ADD A    CKSM
1149 B7 A016         STA A    CKSM
114C 32              PUL A
114D 39              RTS
```

```
03210 114E 86 11    LOAD   LDA A  #$11
03220 1150 BD E1D1         JSR    OUTEEE
03230 1153 86 3C           LDA A  #$3C
03240 1155 B7 8007         STA A  $8007
03250 1158 39              RTS
03270 1159 37       INCHP  PSH B
03280 115A BD E1A5         JSR    SAV

03290 115D A6 00    IN1    LDA A  X
03300 115F 2B FC           BMI    IN1
03320 1161 6F 02           CLR    2,X
03330 1163 BD E1F3         JSR    DE
03340 1166 BD E1EF         JSR    DEL
03350 1169 C6 04           LDA B  #4
03360 116B E7 02           STA B  2,X
03370 116D 58              ASL B


03390 116E BD E1EF IN3     JSR    DEL
03400 1171 0D              SEC
03410 1172 69 00           ROL    X
03420 1174 46              ROR A
03430 1175 5A              DEC B
03440 1176 26 F6           BNE    IN3


03450 1178 BD E1EF         JSR    DEL
03460 117B 7E E1E3         JMP    IOUT2
```

RU4K BASIC OBJECTIVE LISTING

```
END OF DUMP? 10FF
0100 - 7E 08 0E 7E 08 15 54 4F 1E 99 99 53 54 45 50 1E
0110 - 88 88 52 55 4E 1E 08 76 4C 49 53 54 1E 08 9D 4E
0120 - 45 57 1E 08 0E 50 41 54 1E 08 EE 4C 4F 41 1E 09
0130 - 28 53 41 56 1E 09 00 47 4F 53 55 42 1E 0A 6A 47
0140 - 4F 54 4F 1E 0A 8C 4F 4E 1E 0A 4B 54 48 45 4E 1E
0150 - 0A 39 50 52 49 4E 54 1E 0C 82 4C 45 54 1E 0D D5
0160 - 49 4E 50 55 54 1E 0A D7 49 46 1E 0F E0 52 45 41
0170 - 44 1E 0C 2B 44 41 54 41 1E 0D F9 52 45 53 54 4F
0180 - 52 45 1E 0C 79 45 4E 44 1E 08 15 52 45 54 55 52
0190 - 4E 1E 0A B2 44 49 4D 1E 0E 21 46 4F 52 1E 0E A2
01A0 - 4E 45 58 54 1E 0F 53 52 45 4D 1E 0D F9 41 50 50
01B0 - 1E 09 2B 53 54 4F 50 1E 0A C6 1E 0D D5 52 4E 44
01C0 - 28 1E 10 BE 54 41 42 28 1E 0C C7 49 4E 54 28 1E
01D0 - 10 7C 43 48 52 24 28 1E 0C BA 43 48 52 28 1E 0C
01E0 - BA 41 42 53 28 1E 10 B5 53 47 4E 28 1E 10 9A 55
01F0 - 53 45 52 28 1E 10 6E 13 14 0D 0A 15 52 45 41 44
0200 - 59 1E 20 44 45 4C 1E 10 16 1E 52 45 2D 45 4E 54
0210 - 45 52 1E 45 52 52 4F 52 23 20 1E 20 49 4E 20 4C
0220 - 49 4E 45 20 1E CE 02 02 8D 6A 20 07 86 3F 8D 48
0230 - BD 03 59 CE 00 B0 8D 45 81 18 27 E9 81 0D 27 25
0240 - 81 0F 26 0C 86 5F 8D 30 8C 00 B0 27 E9 09 20 E6
0250 - 8C 00 F8 26 05 C6 21 7E 08 47 A7 00 08 20 D7 86
0260 - 23 8D 15 20 CE 86 1E A7 00 DF AE 96 85 26 02 8D
0270 - 31 39 7E E0 BF 7E E0 C8 8D 09 7E E1 D1 BD E1 AC
0280 - 36 20 08 36 B6 80 04 2B 09 8D F2 81 03 26 03 7E
0290 - 08 15 32 39 8D 05 20 0A 8D DE 08 A6 00 81 1E 26
02A0 - F7 39 8D 10 CE 02 AC 8D F2 8D 1E 39 0D 0A 15 FF
02B0 - FF FF FF 1E DF 38 DE 3A 09 09 DF 3A 36 96 38 A7
02C0 - 00 96 39 A7 01 32 DE 38 39 DE 3A EE 00 7C 00 3B
02D0 - 7C 00 3B 39 8D DE BD 04 4E 9F 28 35 DE 3A EE 00
02E0 - 20 11 8D D0 BD 04 4E 9F 28 35 09 09 09 09 09 09
02F0 - 09 EE 00 C6 05 32 A7 00 08 5A 26 F9 32 32 A7 00
0300 - 9E 28 8D C5 39 8D AD 9F 28 35 20 0A 8D A6 BD 04
0310 - 4E 9F 28 AE 00 34 C6 05 DE 5D 32 A7 00 08 5A 26
0320 - F9 32 A7 01 6F 00 9E 28 BD 04 47 8D 9C 39 BD 02
0330 - 75 A6 00 08 BD 02 B4 CE 01 12 DF 48 97 49 DE 48
0340 - 09 09 A6 00 81 1E 26 F9 08 08 08 BD 02 9B 8D 09
0350 - 7F 00 40 BD 02 C9 7E 02 94 36 86 20 BD 0D 0B 32
0360 - 39 BD 07 60 BD 04 33 25 26 16 A6 01 BD 04 33 25
0370 - 20 BD 07 A5 BD 02 B4 DE 34 BD 04 BA DF 34 BD 02
0380 - C9 EE 00 AD 00 BD 04 47 DE 34 31 31 31 31 39 0B
0390 - 39 BD 04 3B 24 07 81 28 27 03 09 86 20 08 08 BD
03A0 - 02 B4 DE 2A 9C 46 0D 27 09 E1 00 26 0C A1 01 26
03B0 - 08 0C DF 63 BD 02 C9 0A 39 36 A6 01 81 28 32 27
03C0 - 05 BD 04 5D 20 DE EE 04 20 DA BD 02 83 8D 92 28
03D0 - 01 39 36 25 31 DF 34 DE 63 81 28 27 15 08 08 DF
03E0 - 63 DE 5D 96 63 A7 00 96 64 A7 01 8D 5A 32 DE 34
03F0 - 0C 39 BD 0D FF 24 04 8D 74 20 01 5F 37 8D 6E 17
0400 - 33 BD 0E 75 20 D9 DF 34 DE 63 E7 00 A7 01 81 28
0410 - 26 19 C6 0A E7 02 E7 03 BD 0D FF 25 03 5F E7 03
0420 - A6 02 BD 0E 5D 6D 03 27 D2 20 CC 8D 30 DF 46 DE
0430 - 63 20 AA 81 41 2B 0C 81 5A 2F 0A 81 30 2B 04 81
0440 - 39 2F 02 0D 39 0C 39 DE 5D 8D 13 DF 5D 39 DE 5D
0450 - 8D 03 20 F7 09 09 09 09 09 09 09 09 39 08 08 08
0460 - 08 08 08 08 08 9C 44 2B 03 7E 0A 0B 39 BD 02 B4
0470 - 8D DC A6 06 81 04 2F 05 C6 01 7E 08 47 4F 5F 6D
0480 - 06 23 19 58 49 D7 52 97 51 58 49 58 49 DB 52 99
0490 - 51 EB 00 89 00 BD 05 5C 6A 06 20 E3 4D 26 D9 BD
04A0 - 02 C9 39 BD 07 60 BD 03 CA 25 04 BD 03 0C 39 BD
04B0 - 0B 3B 25 01 39 81 28 26 11 08 8D 33 BD 07 60 26
04C0 - 02 26 02 08 39 C6 13 7E 08 47 C6 06 20 F9 8D D3
04D0 - BD 07 60 81 2A 26 0B 08 BD 07 60 8D C6 BD 06 E6
04E0 - 20 EE 81 2F 26 08 08 8D BA BD 06 6E 20 E2 39 BD
04F0 - 07 60 81 2D 26 07 08 8D D5 8D 2D 20 07 81 2B 26
0500 - 01 08 8D CA BD 07 60 81 2B 26 08 08 8D C0 BD 06
0510 - 07 20 F1 81 2D 26 08 08 8D B4 BD 06 04 20 E5 39
0520 - BD 02 B4 BD 04 5E 20 0C BD 02 B4 DE 5D 09 09 20
0530 - 06 BD 02 B4 BD 04 60 36 37 C6 06 86 99 A0 00 A7
0540 - 00 09 5A 26 F6 BD 04 5F 0D C6 06 86 00 A9 00 19
0550 - A7 00 09 5A 26 F5 BD 02 C9 33 32 39 36 8D 08 A6
```

```
0560 - 00 84 0F A7 00 32 39 36 37 DF 57 C6 04 DE 57 BD
0570 - 04 60 68 00 86 05 09 69 00 4A 26 FA 5A 26 EE 33
0580 - 32 39 36 37 DF 57 A6 00 84 F0 97 53 C6 04 DE 57
0590 - 64 00 86 05 08 66 00 4A 26 FA 5A 26 F1 DE 57 A6
05A0 - 00 9B 53 A7 00 33 32 39 BD 02 B4 BD 04 4E 7F 00
05B0 - 56 BD 0D BC 24 19 A6 00 2A 0B 97 56 BD 05 31 86
05C0 - 0F A4 00 A7 00 A6 00 26 08 8D 91 6A 06 20 F6 6F
05D0 - 06 6F 05 A6 06 81 65 2D 15 37 C6 05 86 99 A7 00
05E0 - 08 5A 26 FA 86 64 A7 01 BD 04 57 33 20 D1 81 9D
05F0 - 2E 03 BD 0B F0 7D 00 56 27 03 BD 05 31 BD 04 47
0600 - BD 02 C9 39 BD 05 28 BD 02 B4 BD 04 4E BD 0D BC
0610 - 24 28 BD 05 82 6C 06 BD 04 4E BD 0D BC 24 11 BD
0620 - 05 82 6C 06 A6 06 A1 0D 27 08 2D F3 8D 10 20 EF
0630 - 8D 0C 8D 23 BD 04 47 BD 05 A8 BD 02 C9 39 DE 5D
0640 - 37 36 C6 07 A6 00 36 A6 07 A7 00 32 A7 07 08 5A
0650 - 26 F2 DE 5D 32 33 39 36 37 DE 5D C6 06 0C A6 05
0660 - A9 0C 19 A7 05 09 5A 26 F5 DE 5D 33 32 39 BD 02
0670 - B4 BD 0B F0 BD 04 4E BD 0D BC 25 05 C6 08 7E 08
0680 - 47 60 06 8D 38 BD 05 82 BD 05 20 86 0B 5F 5C 8D
0690 - C6 6D 00 2A F9 5A BD 05 20 8D BC BD 05 20 BD 04
06A0 - 5E BD 04 5E BD 05 67 EB 05 E7 05 DE 5D BD 05 67
06B0 - 4A 26 DA BD 04 47 8D 86 7C 00 50 20 59 BD 05 82
06C0 - 4F 6D 00 2A 05 BD 05 31 86 80 BD 04 4E 6D 00 2A
06D0 - 05 BD 05 31 8B 80 97 4A A6 06 AB 0D 28 05 86 78
06E0 - 24 01 40 97 50 39 BD 02 B4 BD 04 4E 8D CF DF 59
06F0 - BD 04 47 BD 06 3E BD 0B F0 86 09 DE 59 E6 00 BD
0700 - 05 5C 5D 27 06 BD 06 57 5A 20 F7 DE 5D BD 04 5E
0710 - BD 05 82 4A 26 E5 BD 04 4E BD 06 3E 96 50 A7 06
0720 - BD 04 47 BD 05 A8 7D 00 4A 2A 03 BD 05 28 BD 02
0730 - C9 39 96 32 D6 33 D0 31 92 30 25 1E DE 2E 96 30
0740 - D6 31 E0 01 A2 00 25 14 26 03 5D 27 10 08 08 A6
0750 - 00 81 1E 26 F9 08 9C 2A 26 E4 DE 2A 0D DF 2C 39
0760 - A6 00 81 20 26 03 08 20 F7 39 BD 0B 3B 24 05 C6
0770 - 07 7E 08 47 DF AC BD 04 4E E6 06 23 F2 C1 04 2E
0780 - EE 86 05 10 4D 27 06 BD 05 82 4A 20 F7 A6 01 97
0790 - 30 A6 02 97 31 DE AC 0C 39 DE 34 A6 00 08 81 1E
07A0 - 26 F9 DF 36 39 DF AC 9F 28 CE 01 BC 20 12 DF AC
07B0 - 9F 28 CE 01 05 20 09 8D A7 DF AC 9F 28 CE 01 11
07C0 - 9E AC 34 08 32 81 20 27 FB E6 00 C1 1E 27 18 11
07D0 - 27 F1 08 8C 01 BA 27 17 8C 01 F4 27 18 E6 00 C1
07E0 - 1E 26 EF 08 08 20 D9 08 9F AC 9F 34 9E 28 39 9E
07F0 - 28 CE 01 BB 39 7E 0B 2B CE 12 00 DF 2E DF 2A DF
0800 - 46 4F 97 32 97 33 97 40 CE 10 7B DF 67 39 8E A0
0810 - 45 8D E5 20 61 8E A0 45 CE A0 7F DF 3A 7F 00 85
0820 - CE 01 F7 BD 02 94 7F 00 40 BD 02 5F CE 00 B0 BD
0830 - 07 60 BD 04 3B 25 05 BD 09 59 20 EA 81 1E 27 E6
0840 - BD 07 B7 EE 00 6E 00 8E A0 45 BD 02 A2 CE 02 13
0850 - BD 02 9B D7 20 CE 00 20 BD 02 72 CE 02 1B BD 02
0860 - 9B DE 5B 96 34 26 07 CE 00 30 6F 00 6F 01 BD 02
0870 - 75 BD 02 A2 20 9F DE 2E DF 3C DF 36 CE 00 75 DF
0880 - 65 CE 11 80 DF 5F DE 2A DF 46 4F 09 08 A7 00 9C
0890 - 44 27 07 A6 00 27 F5 09 DF 44 7E 0A 10 CE 02 07
08A0 - DD 02 94 DE 34 BD 07 60 81 1E 27 2B BD 07 6A DF
08B0 - 34 BD 07 3C DF 24 DE 34 BD 07 60 81 1F 27 04 08
08C0 - BD 07 6A 4F C6 01 DB 31 19 D7 31 99 30 19 97 30
08D0 - BD 07 3C DE 24 20 06 DE 2A DF 2C DE 2E 9C 2C 27
08E0 - 0A 9C 2A 27 06 BD 03 2E 08 20 F2 7E 0D F9 BD 07
08F0 - 99 CE 0A 10 FF A0 46 8E A0 40 BF A0 08 7E E0 E3
0900 - DE 2E 86 12 BD 02 78 8D 3A 8D 38 8D 41 9C 2A 27
0910 - 0D 86 02 BD 02 78 BD 03 2E 08 8D 29 20 EF 86 03
0920 - BD 02 78 8D 29 7E 08 15 BD 07 F8 86 11 97 85 BD
0930 - 02 78 BD 02 7D 81 02 26 F9 BD 02 33 CE 00 B0 8D
0940 - 18 20 EF 8D 00 5F 4F 4A 26 FD 5A 26 F9 39 C6 32
0950 - 86 FF BD 02 78 5A 26 F8 39 BD 07 6A BD 07 32 24
0960 - 13 DE AC BD 07 60 81 1F 27 21 DE 2C 9C 2A 27 1C
0970 - 8D 48 20 17 DE AC BD 07 60 81 1E 26 0A DE 2A 9C
0980 - 2E 27 08 8D 0F 20 04 8D 0B 8D 2F 39 8D 2C DE 30
0990 - DF 32 20 F7 9F 28 DE 2C 9E 2A 08 08 34 34 A6 00
09A0 - 34 08 81 1E 26 F8 9F 2A 9F 46 35 DE 2C 9C 2A 27
09B0 - 06 32 A7 00 08 20 F6 9E 28 39 DE AC BD 07 B7 9F
09C0 - 28 DF 48 DE 2A DF 20 D6 AF D0 AD CB 04 DB 2B 86
09D0 - 00 99 2A 91 44 22 34 D7 2B 97 2A DE 2A DF 46 35
09E0 - DE 20 9C 2C 27 06 09 A6 00 36 20 F6 DE 2C 96 30
09F0 - A7 00 08 96 31 A7 00 08 96 49 A7 00 08 9E AC 34
0A00 - 32 A7 00 08 81 1E 26 F8 9E 28 39 C6 14 7E 08 47
0A10 - CE 01 12 DF 48 CE 11 02 DF 5D DE 36 DF 5B 9C 2A
0A20 - 26 03 7E 08 15 7D 00 36 27 F8 08 08 A6 00 08 DF
0A30 - 34 97 49 DF 48 EE 00 6F 00 DE 34 BD 07 60 BD 04
0A40 - 3B 24 49 7E 0F F5 C6 20 7E 08 47 DE 34 BD 04 EF
0A50 - BD 04 6D 5D 27 F0 5A D7 55 BD 07 B7 EE 00 8C 0A
0A60 - 8C 27 2C 8C 0A 6A 27 05 20 DC 7F 00 55 DE 36 BD
0A70 - 07 99 DE 65 8C 00 85 26 05 C6 09 7E 08 47 96 36
0A80 - A7 00 08 96 37 A7 00 08 DF 65 20 03 7F 00 55 DE
0A90 - 34 BD 07 6A 7A 00 55 2B 0A BD 07 60 81 2C 26 A6
0AA0 - 08 20 EE BD 07 32 24 05 C6 07 7E 08 47 DF 36 7E
0AB0 - 0A 10 DE 65 8C 00 75 26 05 C6 10 7E 08 47 09 09
0AC0 - DF 65 EE 00 20 E7 CE 01 B3 BD 02 9B BD 03 59 DE
0AD0 - 36 BD 02 75 7E 08 15 96 34 26 05 C6 02 7E 08 47
0AE0 - BD 02 2C CE 00 B0 DF AC DE 34 BD 03 CA 25 31 DF
0AF0 - 34 DE AC 8D 3B 24 12 81 1E 27 06 CE 02 0A BD 02
0B00 - 94 BD 02 2C CE 00 B0 20 EA BD 02 E2 BD 07 60 81
0B10 - 2C 26 01 08 DF AC DE 34 BD 07 60 08 81 2C 27 CA
0B20 - 09 7F 00 40 81 1E 26 03 7E 0D F9 C6 03 7E 08 47
0B30 - BD 07 60 97 4A 08 81 2D 27 04 09 7F 00 4A 4F 97
0B40 - 4C 97 4D 97 4E BD 0B F0 D6 5D D7 26 D6 5E D7 27
0B50 - C6 05 BD 07 60 BD 04 3B 24 0B 81 2E 26 05 97 4D
0B60 - 08 20 EF 0D 39 09 08 A6 00 BD 04 3B 25 42 80 30
0B70 - 26 0F 7D 00 4C 26 0C 7D 00 4D 27 EA 7A 00 4B 20
0B80 - E5 97 4C BD 02 B4 DE 26 5D 27 16 7D 00 4E 26 08
0B90 - AB 00 A7 00 08 5A 20 06 48 48 48 48 A7 00 73 00
0BA0 - 4E DF 26 7D 00 4D 26 03 7C 00 4B BD 02 C9 20 B6
0BB0 - 7D 00 4D 26 08 81 2E 26 04 97 4D 20 A9 5F 81 45
0BC0 - 26 14 08 A6 00 81 2D 27 09 81 2B 26 01 08 8D 36
0BD0 - 20 04 08 8D 31 50 96 4B 1B BD 02 B4 DE 5D A7 06
0BE0 - BD 04 47 BD 02 C9 7D 00 4A 27 03 BD 05 28 0C 39
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0C60 - D9 BD 02 E2 08 DF 3C DE 34 BD 07 60 08 81 2C 27
0C70 - BC 09 81 1E 26 D0 7E 0D F9 DE 2E DF 3C DE 34 7E
0C80 - 0D F9 DE 34 BD 07 60 81 22 26 14 08 A6 00 08 81
0C90 - 22 27 4A 81 1E 26 04 C6 04 20 1C 8D 6E 20 ED 81
0CA0 - 1E 26 35 09 A6 00 08 81 3B 27 06 BD 02 A2 7F 00
0CB0 - 40 08 DF 36 7E 0A 10 7E 08 47 DE 34 BD 04 6D 17
0CC0 - 8D 49 8E A0 45 20 16 DE 34 BD 04 6D D0 40 23 F2
0CD0 - BD 03 59 5A 26 FA 20 EA BD 04 EF 8D 4B BD 07 60
0CE0 - 81 2C 26 0E 08 96 40 16 C4 F0 10 27 0A BD 03 59
0CF0 - 20 F3 81 3B 26 04 08 7E 0C 84 81 1E 27 A1 C6 06
0D00 - 20 B5 86 2E 20 05 4F 84 0F 8B 30 36 BD 02 78 32
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0D30 - 4D 6D 00 26 08 8D CF BD 02 C9 7E 03 59 6D 00 2A
0D40 - 07 86 2D 8D C6 BD 05 31 A6 06 81 09 2E 31 81 FF
0D50 - 2D 2D 4D 2E 10 8D AF 8D A9 97 4D 6D 06 2A 1C 8D
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0D70 - 5C 6A 06 26 F5 8D 45 24 BE 8D 87 8D 30 20 B8 A6
0D80 - 00 8D 84 BD 05 5C BD 0D 02 8D 22 86 45 BD 0D 0B
0D90 - E6 06 5A 2A 06 86 2D BD 0D 0B 50 4F 4C C0 0A 2A
0DA0 - FB 4A CB 0A BD 0D 07 17 BD 0D 07 20 8A 8D 0D 24
0DB0 - 0A A6 00 BD 0D 07 BD 05 5C 20 F2 39 BD 02 B4 DE
0DC0 - 5D 37 C6 06 6D 00 26 07 08 5A 26 F8 0C 20 01 0D
0DD0 - BD 02 C9 33 39 DE 34 BD 03 CA 24 05 C6 12 7E 08
0DE0 - 47 BD 07 60 08 81 3D 27 04 C6 06 20 F1 BD 04 EF
0DF0 - 81 1E 26 F5 BD 02 E2 20 00 BD 07 99 7E 0A 10 BD
0E00 - 02 B4 DE 34 BD 04 EF 08 81 2C 27 0B 81 29 26 1A
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0E60 - E6 03 8D 11 BD 04 5F DF 46 BD 02 C9 96 46 A7 04
0E70 - 96 47 A7 05 39 4D 26 05 C6 15 7E 08 47 A1 02 22
0E80 - F7 E1 03 22 F3 36 A6 02 97 51 5D 27 0D 5A 27 0A
0E90 - 96 51 BD 04 5F 4A 26 FA 20 F3 32 BD 04 5F 4A 26
0EA0 - FA 39 DE 34 BD 03 CA 24 03 7E 0D DC DF 34 DE 5D
0EB0 - BD 04 55 A6 00 E6 01 CE 11 80 9C 5F 27 0F A1 00
0EC0 - 26 04 E1 01 27 07 BD 04 5D 20 EF DE 5F 8C 12 00
0ED0 - 26 05 C6 10 7E 08 47 A7 00 08 E7 00 08 DF 5F DE
0EE0 - 34 BD 07 60 08 81 3D 27 03 7E 0D E9 BD 04 EF BD
0EF0 - 02 E2 BD 07 AE 8C 01 09 26 EF DE 34 BD 04 EF DF
0F00 - 34 DE 5F BD 02 D4 BD 04 5F DF 5F DE 34 BD 07 AE
0F10 - 8C 01 10 26 09 DE 34 BD 04 EF DF 34 20 0E DE 5D
0F20 - BD 0B F0 86 01 A7 00 A7 06 BD 04 47 DE 5F BD 02
0F30 - D4 BD 04 5F DF 5F DE 34 BD 07 60 81 1E 26 AA 08
0F40 - DF 36 DE 5F D6 36 E7 00 08 D6 37 E7 00 08 DF 5F
0F50 - 7E 0A 10 DE 34 BD 03 CA 24 03 7E 0D DC BD 07 60
0F60 - 81 1E 26 D9 08 DF 36 BD 04 4E A6 00 E6 01 DE 5F
0F70 - 8C 11 80 27 66 DF 5F 8C 11 80 27 5B BD 04 54 BD
0F80 - 04 54 A1 00 26 EF F1 01 26 EB DF 61 EE 00 BD 03
0F90 - 05 DE 61 BD 04 5D 86 02 6D 00 2A 02 8B 03 97 4F
0FA0 - BD 03 05 BD 06 07 CE 00 6F BD 02 D4 BD 04 47 DE
0FB0 - 61 08 08 BD 03 05 BD 10 3A 24 07 DE 61 DF 5F 7E
0FC0 - 0A 10 CE 00 6F BD 03 05 DE 61 EE 00 BD 02 D4 DE
0FD0 - 61 EE 0E DF 36 20 E8 C6 18 20 02 C6 17 7E 08 47
0FE0 - DE 34 BD 04 EF 8D 17 97 4F BD 04 EF DF 34 8D 4A
0FF0 - 24 03 7E 0D F9 DE 34 BD 07 B7 EE 00 6E 00 BD 07
1000 - 60 08 81 3D 26 03 86 00 39 E6 00 81 3C 26 13 C1
1010 - 3D 26 04 08 86 02 39 C1 3E 26 04 08 86 03 39 86
1020 - 01 39 81 3E 27 05 C6 06 7E 08 47 C1 3D 26 04 08
1030 - 86 05 39 C1 3C 27 E4 86 04 39 96 4F 48 48 CE 10
1040 - 54 DF 20 9B 21 97 21 BD 06 04 BD 04 4E A6 00 DE
1050 - 20 4D 6E 00 27 16 20 12 2B 12 20 0E 2B 0E 20 F4
1060 - 26 0A 20 06 27 04 2B 02 2A 02 0D 39 0C 39 BD 04
1070 - 4E BD 02 B4 DE 67 AD 00 BD 02 C9 39 BD 04 4E C6
1080 - 09 E0 06 5D 2F 08 BD 05 82 6C 06 5A 20 F5 6F 05
1090 - BD 04 47 BD 05 A8 BD 04 4E 39 BD 04 4E A6 00 27
10A0 - 13 97 4A BD 0B F0 86 01 A7 00 A7 06 7D 00 4A 2A
10B0 - 03 BD 05 31 39 BD 04 4E 6D 00 2A F8 20 F3 BD 04
10C0 - 4E BD 0D BC 24 05 BD 04 47 20 06 CE 00 69 BD 03
10D0 - 05 CE 10 F9 BD 03 05 BD 06 E6 BD 04 4E BD 05 5C
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10F0 - 05 A8 CE 00 69 BD 02 D4 39 08 37 25 41 69 00
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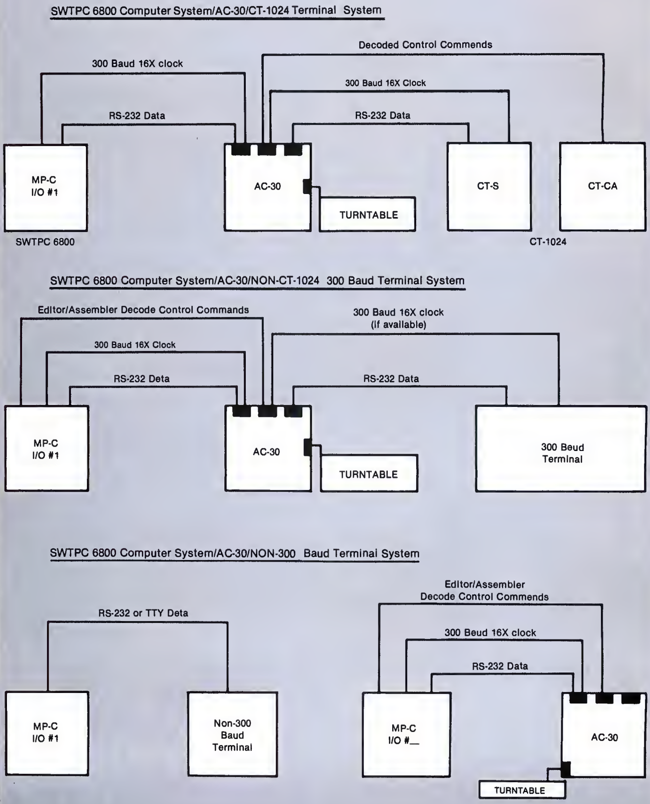
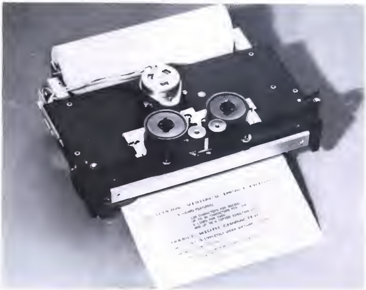


Figure 2. Interconnection Block Diagrams

Peripheral Vision impacts your computer.



WITH A FULL-SIZE, LOW-COST IMPACT PRINTER.

Until now, the hobbyist and small businessman have had one major problem in assembling a reasonably price microprocessor system with the capabilities found in the more costly computers. It was impossible to find a high-quality, high-output printer for hard copy needs at an affordable price.

Peripheral Vision has come up with a solution.

We are offering a full-size *impact* printer designed for microprocessors—and it comes with a mini price. Kit prices start as low as $495 for the printer and interface card. And that won't impact your pocketbook.

Peripheral Vision's printer is loaded with capabilities. Take a look:

- It's fast—120 characters per second
- 96 characters per line, 12 characters per inch horizontal, 6 lines per inch
- Makes up to 4 copies simultaneously
- Character set and pitch variable under software control
- 5 x 7 character matrix
- Ribbon has built-in re-inkers for a life of 10,000,000 characters
- Paper can be either a standard 8½-inch roll, fanfold or cut page
- Interfaces to 8-bit parallel ports

Just remember, Peripheral Vision is committed to helping you get along with your computer. The new printer we are offering is another example. It is high quality, low in cost and will definitely impact your system.

Write or call now to find out how to impact your computer.

PERIPHERAL VISION INC

P.O. Box 6267 Denver, Colorado 80206 (303) 777-4292

The Small Computer

Twenty-five years ago a computer as powerful as the new Processor Technology Sol-20 priced out at a cool million.

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Robert 4K

by William W. Turner

FOREWORD

This article is one of a series covering the 6800 microcomputer 4K BASIC Interpreter program developed by Robert Uiterwyk of MicroComputer Systems, Inc. A copy of this program is included in this issue in the form of an object-coded floppy platter. This article covers the 4K BASIC Interpreter grammar and its companion piece by William Blomgren covers the theme of how to load this BASIC Interpreter program into your 6800 microcomputer.

INTRODUCTION

The following Table 1, SUMMARY OF BASIC FEATURES, explains the characteristics of the 6800 4K BASIC Interpreter program. For convenience Robert Uiterwyk's 4K BASIC also carries the mnemonic name RU4KBASIC.

TABLE 1 SUMMARY of BASIC FEATURES

COMMANDS	*STATEMENTS*		*FUNCTIONS*
LIST	REM	END	ABS
RUN	DIM	GOTO*	INT
NEW	DATA	ON...GOTO*	RND
SAVE	READ	ON...GOSUB*	SGN
LOAD	RESTORE	IF...THEN*	CHR
PATCH	LET*	INPUT	USER
	FOR	PRINT*	TAB
	NEXT	PATCH*	
	STOP	RETURN	
	GOSUB*		

*Flags statements that may be used in the direct mode (No statement numbers)

MATH OPERATORS		*RELATIONAL OPERATORS*	
−	Unary negation	=	Equal
*	Multiplication	<>	NOT Equal
/	Division	<	Less than
+	Addition	>	Greater than
−	Subtraction	<=	*Less than or Equal*
		>=	Greater than or Equal

Line Numbers	may be from 0001 to 9999	
Variables	Simple variables:	Single alphabetic or Single alphabetic and a single digit
	Arrays:	Single alphabetic
Backspace	Control-O	
Line delete	Control-X	
Panic Button	Control-C should bring Basic back to the READY mode regardless of what the BASIC user program is doing.	

BASIC PROGRAM FORMAT

A BASIC program is comprised of programming statements. These statements tell the computer in a step-by-step sequence how to perform a particular task. The computer has no intelligence of its own, and only understands what it has been programmed to do. The BASIC language has some simple but exacting rules on how to instruct a computer how to do a particular task. For instance, the format of a BASIC programming statement is always a statement number, followed by the statement body, and terminated by a carriage return. The statement body always starts with a keyword that identifies the type of statement.

Statements need not be entered in numerical order, because the BASIC interpreter will automatically sort the statements in ascending order by line numbers. The statement number is also used for reference purposes, as will be seen when discussing the GOTO, GOSUB and IF statements. All line numbers must be between 1 and 9999, and zero may not be used. A programming statement may contain no more than 72 characters including blanks. Unless within a character string and enclosed by quotation marks ("), blanks are *not* processed by BASIC, and their use is optional. With blanks, the statement is more readable, as can be seen in Figure 1, but will require a slightly longer time to process. In addition typing blanks in the statements will require more memory for the storage of the program. Keep in mind, though, that program readability is very important; for if you cannot read it, you cannot modify or fix it! The only place in BASIC that blanks may not be used at all, is inside the various keywords and inside numbers. "12 34" is *NOT* the same as "1234".

Programming Statement	Memory required
110 LET A = B + (3.5*5E2)	23 Bytes
110LETA=B+(3.5*5E2)	16 Bytes

Figure 1 Statements with and without imbedded blanks.

In any one program, a line number may be used only once. A previously entered line may be changed by entering the same line number along with the desired new statement. Typing just a line number followed by a carriage return will delete that line.

It is strongly suggested that you use line numbers which are at least ten numbers apart. This will make it easier to add in statements between the original statements in case of omission, or if you desire to add additional features to an existing program. If you do wish to insert a statement between two others, you need only type a line number that falls between the other two. For example consider the following original BASIC program:

Uiterwyk's BASIC

```
180 LET P=A*A*3.14
185 PRINT
```

in which it is desired to insert the following addition program statement

```
183 REM INSERT THIS LINE
```

with the resulting program becoming:

```
180 LET P=A*A*3.14
183 REM INSERT THIS LINE
185 PRINT
```

If it is desired to replace a statement, a new statement is typed that has the same line number as the one to be replaced. For example, typing the statement:

```
180 P=(A*A)*3.14
```

would cause the example program to become:

```
180 P=(A*A)*3.14
183 REM INSERT THIS LINE
185 PRINT
```

Each line is terminated by a carriage return. Only after the carriage return is typed will BASIC store the new statement in the proper sequence in its memory. If after typing a line and before typing the carriage return, you should change your mind, simply enter a "control-X" (Control key depressed and X key struck) to delete the line. Single character typing errors can be corrected by typing a "control-0" for a backspace. The computer will print either a left-arrow (←) or an underline (_) for each "control-0" pressed, and will backspace across the characters stored in the input buffer. The character displayed in response to a "control-0" will vary depending on the terminal used. If it is desired to stop a running program, or to terminate a LIST command, you should use the "control-C" character.

VARIABLE NAMES AND DATA FORMATS

Now that you know how to enter a program, correct any mistyped lines, and how to stop a running program, we should probably find out how the "numbers" that control the program flow are referenced.

All numbers which can be changed during the execution of a program are called *variables*. Those numbers whose values cannot be changed other than by retyping a programming statement are called *constants*. Variables are referenced by a unique name given them by the programmer. A simple variable may be given a name of a single alphabetic or a single alphabetic character followed by a single digit 0 thru 9. Thus legal names for a simple variable are: A, B, Z0, Q5. Illegal names are 9, 5A, A34, AB. BASIC also has a type of variable known as an array. An array is defined as an ordered collection of numeric data known to BASIC under a single name. An array may be given a name of a single alphabetic character, A to Z. BASIC allows the use of both the simple variable A and the array A in the same program.

Arrays are divided into columns (vertical) and rows (horizontal). Arrays may have one or two dimensions. For example:

1.01
2.11
3.22
4.34

is a one dimensional array while

6	5	4
3	2	1
0	9	8

is a two dimensional array.

Array elements are referenced by their column and row position. For instance, if the examples above were arrays A and Z respectively, 2.11 would be A(2); similarly, 0 would be Z(3,1). The references to array elements are called subscripts, and set apart with parentheses. For example P(1,5) references the fifth element of the first row of array P; 1 and 5 are the subscripts. In X(M,N), M and N are the subscripts.

The range of numbers that can be stored in a single element of an array, or in a simple variable is 1.0 x 10^{-99} to 9.99999999 x 10^{99}. There nine digits of significance in this version of BASIC. There will be no radix or base conversion errors in this version of BASIC, because all numbers are stored internally in an exponential (floating point) base 10 format. All numbers are internally truncated to nine digits to fit this precision. Numbers may be entered and displayed in three formats: INTEGER, DECIMAL, and EXPONENTIAL. BASIC will automatically select the appropriate output format when executing a "PRINT" statement. Figure 2 identifies the three formats and gives examples.

INTEGER (NO DECIMAL POINT)
1 998 10 999999999

DECIMAL (FLOATING POINT NUMBERS)
.123456789 3.14 9.9965

EXPONENTIAL (SCIENTIFIC NOTATION)
10E99 −1.2345E76 1.2E−99

E99 REPRESENTS 10^{99} AND E−99 IS 10^{-99}
(E STANDS FOR EXPONENT)

Figure 2. Data Formats

COMMANDS

Although most BASIC statements will have line numbers, it is possible to communicate in BASIC by typing certain types of statements without line numbers. This type of statements is called *commands*. A command is a BASIC statement that causes immediate action. In contrast, however, a typical BASIC program is entered into the computer by typing it a line at a time; later typing a command (RUN) to cause the computer to begin executing the program in accordance with the programming statements previously stored in the computer's memory. When BASIC is ready for you to type a command or is able to accept a programming statement for storage, the word "READY" is displayed on the terminal. After each such entry the system will prompt for an additional command or programming statement by displaying a "#". When a command is typed, the computer will take immediate action on that command, and when the command has completed it will again respond with the word "READY" and a "#".

This version of BASIC will understand seven different commands: NEW LIST RUN SAVE LOAD APPEND PATCH. Each of these seven commands is described in full in the following section.

COMMAND NAME	DESCRIPTION OF COMMAND
NEW	The NEW command causes the current program to be erased. All working storage, internal pointers, and all variables will be reset. The effect of this command is to erase all traces of a program from memory and to start over.
LIST	The LIST command has several formats which can be used to cause all or selected portions of the current program to be displayed on your terminal. The lines are displayed in sequence with the lowest number first. The different LIST formats are as follows; LIST — will list the entire program from start to finish. LIST 100 — will list only line 100. LIST 100,200 — will list lines 100 thru and including line 200. LIST 100,1 — will cause the program to begin listing at line 100 and will continue through to the end of the program. This operation will occur any time the second line number is less than the first.
RUN	The RUN command causes the current program in memory to begin execution at the first statement number. RUN always starts with the lowest line number and will proceed in sequential order unless directed to do otherwise with a GOTO, GOSUB, ON, or IF statement.
SAVE	The SAVE command causes the current program to be saved in a reloadable format on either the SWTPC AC-30 cassette interface

or on a TELETYPE papertape punch, or an equivalent device. The control characters necessary to control the recording and playback mechanisms are output along with the program. More complete details are given in LOAD.

LOAD The LOAD command will first erase any program currently in working storage (as in the command NEW) and will then load a previously saved program. Control characters are output to control the reading mechanism. More complete details are given in APPEND.

APPEND The APPEND command functions exactly like the LOAD command except that memory is not cleared prior to the load function.

PATCH The PATCH command causes the computer to return to the MIKBUG operating system and outputs a carriage return, line feed, and an '*' on the terminal device. If no memory belonging to BASIC (addresses _______ to _______) and the program counter (addresses A048 and A049) are not changed, typing a "G" will restart BASIC with your program intact. The PATCH command may even be inserted as a programming statement with a line number in your program. When the PATCH statement is encountered, control is transferred to MIKBUG. Upon typing a "G", control will return back to the line that immediately follows the PATCH command.

Note: All seven of the control commands described above may also be used as programming statements, if the control statement is typed following a line number. As a BASIC programming statement their action will be suspended until the program executes them in sequence.

Caution: Using the NEW statement as an executable statement will cause your program to self-destruct!

PROGRAM STATEMENTS

Each program statement line begins with a line number which must be an integer between 1 and 9999. Statements may be entered in any order, but they will be executed in numerical order. Blanks, unless enclosed by quotation marks, are ignored. Program statements are limited to 72 characters including blanks. Nineteen types of program statements are allowed and are described in the following paragraphs. For your convenience the statements are listed in alphabetical order, rather than someone's "easy-to-learn" sequence. This will make it easier to use as a reference manual.

DATA The DATA program statement causes data to be stored as part of a program. This data will be used by a READ statement. Data statements do not execute; they merely specify data. Multiple data items in a data statement must be separated by commas. Data statements may be placed anywhere in a program, and will be read in sequence as required. When the data is read in a pro-

gram, the data will be read in sequence from the first to last data statements, and from left to right within each data statement. Each data item may be read only once unless a RESTORE statement is executed. BASIC keeps track of data with a *pointer.* When the first READ statement is encountered, the pointer indicates that the first data item in the first data statement is to be used; the pointer is then moved to the second item of data, and so on. An example of the DATA program statement format is as follows;
100 DATA 123, 34.5, 695, 500

DIM The DIM program statement allocates memory space for an array. In this version of BASIC, one or two dimensioned arrays are allowed. Maximum array size is 255 x 255 elements. (This is not as much of a limitation as you might think — you would need 393,216 bytes of memory to contain an array of 65535 elements! and this doesn't allow for any memory to store the program code . . .) All array elements are set to zero by the DIM statement. Dynamic re-dimensioning of arrays is not allowed. Once an array has been defined, it must not be re-defined in the same program. If an array is not explicitly defined by a DIM statement, it is assumed to be defined either as an array of 10 elements or as an array of 10 x 10 upon the first reference to it in a program.
An array can be allocated only once in a given program, implicitly and explicitly. Only the variables A thru Z (not followed by a number) may be dimensioned. This does not prevent the use of a simple variable of the same name.
The working size of an array may be smaller than its physical size. For example, an array declared 5 x 5 in a DIM statement may be used to store fewer than 25 elements; the DIM statement supplies only an upper bound on the number of elements. In the example of A(5,5) the first position of this array is A(1,1) and the last is A(5,5). An example of the DIM program statement format is as follows;
10 DIM A(5,5), Z(100,2)

END The END program statement causes the program to stop executing. BASIC will print the word "READY" and a "#" on the terminal device indicating that it is now able to accept commands. In this version of BASIC, END may appear more than once and need not appear at all. It is recommended, however, that the last statement of a program be an END statement. This clearly shows that a program has been completely loaded or saved. An example of the END program statement format is as follows;
9999 END

FOR The FOR program statement allows repetition of a group of statements within a program for a specified number of times. The variable name that follows the word 'FOR' is used to identify the related NEXT statement. In addition the variable is initially set to the value of the first expression (expression1). All statements between the FOR and the related NEXT statement are then executed. The named variable in the FOR statement is then incremented by the STEP

value (expression3) and compared to the upper limit (expression2). If the increment creates a value that is *greater than* the upper limit (expression2) control of the computer is passed to the statement immediately following the NEXT statement. If the increment operation results in a sum that is equal to or less than the upper limit, the programming statements that fall between the FOR and NEXT statements will be repeated. This looping process will be continued until the upper limit has been exceeded, or as the result of an IF statement, control is passed to a statement outside the scope of the programming loop. If no STEP value is specified, a value of + 1 is assumed. The loop will be executed once, regardless of the value of the variable. Although expressions are permitted for the initial, final, and step values in the FOR statement, they will be evaluated only once, the first time the loop is entered. It is not possible to use the same indexed variable in two loops if they are nested. When the statement after the NEXT statement is executed, the variable is equal to the value that caused the loop to terminate, and not the T0 value itself. The step size need not be an integer. For instance,

100 FOR N = 1 to 2 step .01

is a valid statement which will produce exactly 100 loop executions, incrementing N by .01 each time. A negative step size may also be used, as seen below:

100 FOR Q1 = 100 to 50 STEP − 2.5

Examples of proper FOR program statement formats are as follows;

320 FOR K = 1 TO 300

•

•

•

500 FOR variable = expression1 TO expression2 STEP expression3

•

•

•

760 FOR L9 = 200 TO 1 STEP − 1

See the description of NEXT statement for additional information.

GOSUB The GOSUB program statement causes the program to transfer control to the subroutine at the specified line address and returns to the line immediately following GOSUB XXXX. A subroutine is a sequence of instructions which performs a task that has use in more than one place in a program. To be able to use such a sequence of programming statements, BASIC provides the facility (GOSUB) to call upon such a sequence from more than one place in the program.

The subroutine is actually a sequence of instructions that will receive control upon the execution of a GOSUB statement. Upon completion of the subroutine, control is returned back to the mainline of the program by execution of a return statement. The statement that immediately follows the original GOSUB statement will receive control when the RETURN is executed.

Subroutines may be nested to a level of 8 deep. That is, one subroutine may call a subroutine, which can call a subroutine, . . . to a nested depth of 8 subroutines. An

example of the GOSUB program statement format is as follows;

235 GOSUB 9010

GOTO The GOTO program statement transfers control of the computer to the statement number specified. Program control will continue sequentially from the new statement. An example of the GOTO program statement format is as follows;

100 GOTO 375

IF The IF program statement transfers control to a specified statement if the result of a conditional comparison is true.

The IF statement is used to control the sequence of program statements to be executed, depending on specific conditions. If the relational expression is true, then control is given to the statement or statement number declared after the THEN. If the relational expression is false, program execution continues at the statement that immediately follows the IF statement. The possible relational operators for use with the IF statement are as follows;

=	Equal
<>	Not equal
<	Less than
>	Greater than
<=	*Less than or equal*
>=	Greater than or equal

If a BASIC statement is specified after the THEN condition, rather than a statement number, the statement specified will be executed if the conditional expression is true, and control will be passed to the statement immediately following the IF statement.

It is possible to code another IF statement as the statement following the THEN condition —. This will give the equivalent of an "AND" condition.

When evaluating relational expressions, arithmetic operations take precedence in their usual order, and the relational operators are given equal weight and are evaluated last.

Examples of proper IF program statements formats are as follows;

```
190 IF X = 56 THEN 300
•
•
•
200 IF Z9 D+Y-(7*S) THEN PRINT
Z9;" is out of range"
•
•
•
2022 IF expression1 relational-test
expression2 THEN basic-statement
•
•
•
2022 IF expression1 relational-test
expression2 THEN statement-number
```

An example of A program to illustrate IF statements is as follows;

```
10 INPUT X
20 IF X=1  THEN PRINT "EQUAL
        TO 1"
30 IF X<>1 THEN PRINT "NOT
        EQUAL TO 1"
```

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```
40 IF X< 1 THEN PRINT "LESS
               THAN 1"
50 IF X> 1 THEN PRINT "GREATER
               THAN 1"
60 IF X<= 1 THEN PRINT "LESS
               THAN OR EQUAL TO 1"
70 IF X>= 1 THEN PRINT "GREATER
               THAN OR EQUAL TO 1"
80 PRINT
90 GOTO 10
100 END
```

INPUT The INPUT program statement allows users to enter data from the terminal during program execution and to assign that value to a variable. The variable specified may be either a simple variable or a specified element in an array.

When the program comes to an INPUT statement, a question mark is displayed on the terminal. The user then types in the requested data separated by commas and followed by a carriage return. If no data is entered, or if the data entered is insufficient, the system prompts the user for more data with an additional question mark. Only numerical constants can be given in response to an input statement. Any number of variables may be specified on the INPUT statement, within the confines of the 72 character line, and the user must respond with a value for each specified variable. An example of the INPUT program statement format is as follows;

```
100 INPUT A,C,D
```

LET The LET program or assignment statement is used to assign or specify the value of a variable. The value may be an expression, a number, or another variable. The keyword LET is optional, and need not be specified. There are four functions which may be used inside a formula on a LET statement. ABS (absolute value), INT (integer value), RND (random number), and SGN (sign *not sine*) may be used inside formulas or LET statements or anywhere else that a mathematical expression is allowed. Examples of proper LET program statement formats are as follows;

```
100 x = 123.45
110 LET Z9 = INT(RND(0)*100)
120 T5 = (A*A)*3.14
•
•
300 A(1,1) = X + P(M,N)
•
•
400 Z(I) = X
```

NEXT The NEXT program statement is used to define the end of a "FOR . . . NEXT" loop. The variable specified in the NEXT statement identifies the associated FOR statement. Multiple FOR . . . NEXT statements may be used in the same program; They may also be nested (placed inside one another.) When nested, the innermost loop or loops must be wholly contained inside the outermost loop. The range must not overlap. An example of the NEXT program statement format is as follows;

```
220 NEXT K
```

Figure 3 illustrates proper and improper nesting.

PROPER NESTING:

```
100 FOR I = 1 TO 20
 •
 •
 •
150 FOR J = 1 TO 2      Innermost loop
                        is contained
                        totally within
                        the outermost
170 NEXT J              loop.
 •
 •
 •
210 NEXT I
```

IMPROPER NESTING:

```
100 FOR I = 1 TO 20

150 FOR J = 1 TO 2   The loops overlap.
170 NEXT I
210 NEXT J
```

Figure 3. FOR . . . NEXT NESTING

For additional information see the description of the FOR statement.

ON The ON program statement provides a computed GOTO or GOSUB mechanism. Instead of specifying the programming sequence of:

```
10 if X = 1 THEN 100
20 if X = 2 THEN 200
30 if X = 3 THEN 300
40 if X = 4 THEN 400
```

You could have used the following statement;

```
10 ON X GOTO 100,200,300,400
```

The computer would evaluate X, truncate the resulting value to an integer value, would then select the "Xth" statement number in the list of line numbers, and would use that value as part of a "GOTO" statement. Control of the computer would then be received by the selected line number.

In the example given above if the value of X was between 3 and 3.99999999 then the computer would GOTO 300. If the value of X was 1 then the computer would "GOTO 100". If the value of X is less than 1, or greater than the number of items in the list, the computer will generate an error message, and program execution will stop.

ON X *GOSUB* 100,200,300,400 works in a similar manner, except that the specified line numbers are assumed to be the start of a subroutine. When a RETURN statement has been executed, control on the computer will be returned to the statement immediately following the "ON X GOSUB" statement.

Note: The value X in the examples above can be any formula or mathematical expression. (additional note for FORTRAN pro grammers or individuals trying to convert FORTRAN to BASIC:

The FORTRAN IF statement can be simulated in BASIC thru the use of the ON . . . GOTO statement.

FORTRAN: IF (X-Y) 20,50,10

BASIC: ON SGN(X-Y) + 2 GOTO 20,50,10

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(I will leave the determination of the correctness of the above example to the individual programmer needing the technique . . .)

PRINT The PRINT program statement causes the values of any variables specified in the PRINT statement to be output or printed on the terminal device. The PRINT statement can also be used to print out text, by enclosing the desired text to be printed in quotation marks ("). The statement

100 PRINT "HI THERE, I AM A SWTPC COMPUTER"

would cause the text "HI THERE, I AM A SWTPC COMPUTER" to be printed on the terminal device (the quotation marks would not be displayed or printed.)

The PRINT statement also makes use of the comma (,) and semicolon (;) to control the formatting of a print line.

In the statement PRINT A,B the numerical value of A will be printed beginning in the left hand margin, and the numerical value of B will be printed in column 18. Basic defines the 72 column line width into 4 zones starting in columns 18,36,48, and 60. The use of a comma in between data items will cause the printing mechanism to be advanced to the start of the next zone. This feature allows you to prepare tabular table data easily. The semicolon disables this "advance to next zone" mechanism and will cause the data items to be printed one after another. Numeric values will be separated by a blank for readability.

In addition if the PRINT statement is terminated by a semicolon, the computer will suppress the normal "carriage return, line feed", that is, automatically output at the end of each line. PRINT statement used with no operations or data items will cause a single blank line to be output.

This version of BASIC supports two special functions (TAB & CHR) that can be used only on the PRINT statement. The TAB function can be used to format items starting in columns other than 18,36,48, and 60. The CHR function is used to create special control characters that may not be generatable from your keyboard.

READ The READ program statement is similar in function to the INPUT statement except that the next DATA item is read, rather than getting a numeric value from the terminal. READ statements cause values in the DATA buffer to be accessed in a left to right, top to bottom sequential manner and assigned to the variable named in the read statement. If more than one variable is named in the READ, the values read from the DATA statements will be assigned, in the order read to the variables named on the READ statement. For additional information, see the description of the DATA and RESTORE statements. Examples of proper READ program statement formats are as follows;

100 READ A
200 READ a,q9,B

REM The REM program or remark statement allows insertion of a line of remarks or comments in the listing of a program. REM lines are saved as a part of a BASIC program, and are printed when the program is listed,

but they are ignored when the program is executing. An example of the REM program statement is as follows;

300 REM

RESTORE In the discussion on the DATA and READ statements, it was stated that once a data item was read, it could not be re-read. This is only partially true. The RESTORE program statement is used to reset the internal data pointer that BASIC uses, back to the first data item on the first data statement. Thus the entire data list may be re-read from the beginning.

The only way that you can re-read a particular data item, is to keep track of how far down the data list it is; RESTORE the data pointer, and then READ "n-1" numbers throwing all of the previous numbers away. The data pointer has now been "reset" to a particular data item, so that it can be re-read . . . clearly not a very practical technique for most programs!!! An example of the RESTORE program statement format is as follows;

500 RESTORE

RETURN The RETURN program statement is used to define the logical end of a subroutine, and when executed will cause control of the computer to be transferred to the statement immediately following the *last* GOSUB executed. A subroutine may call a subroutine, which calls still another subroutine. This may be done to a nested level of 8 deep. You must take care not to execute a return statement unless you have executed a GOSUB first. An example of the RETURN program statement format is as follows;

1000 RETURN

STOP The STOP program statement operates in a similar fashion to the END statement; both cause the currently running BASIC program to stop running. The STOP statement, however, will identify the line number of the statement that caused the stop; while the END statement merely stops the program without identifying where the "end" occurred. This feature of the STOP statement makes it useful in identifying "error" conditions. For instance, in the following example the computer will print "STOP at 100" if the number typed in response to the INPUT statement is less than zero.

```
90 INPUT X
100 IF X < 0 THEN STOP
```

An example of the STOP program statement format is as follows;

990 STOP

FUNCTIONS

The following functions are available in Robert Uiterwyk's 4K 6800 BASIC.

ABS (x) The ABS or absolute function will take the absolute value of the expression x. If the value of the expression is a negative number then the value return by the absolute function will be a positive value. A positive value will remain a positive value.

if Z9 is a −32 then the ABS(Z9) will be a +32

if Q5 = +6 then the formula ABS(Q5+3) will return a value of +9.

INT (x) The INT or integer function is used to truncate or "chop-off" any decimals in a floating point number. Positive values will be chopped off to the next lower integer, and negative numbers will be rounded up to the next lower value.

INT(9.765) will result in a value of 9.

INT(−10.2) will result in a value of −11.

RND (x) The RND or random number generator generates a pseudo-random number ranging between 0.0 and 1.0. If the argument (x) is not equal to zero, it will be used as a new seed for the random number generator. The value returned as the result of specifying a new seed should be ignored. A new random number *will* be received when the argument specified is zero. In this version of BASIC it is not necessary to seed the generator in order to start a new random series of numbers at the start of a game.

SGN (x) The SGN or sign function returns a −1, 0, or +1 value depending on the magnitude of the expression (x). If x is less than zero, the SGN will return a value of −1. If x is equal to zero, SGN will return a value of zero. If x is greater than zero, SGN will return a +1.

if Z9 is a −45.987 then SGN(Z9) will be a −1

if Q is a +34.59 then SGN(Q) will be a +1

if R is a −10 and S is a −5 then SGN(R-2*S) will be 0.

CHR (x) The CHR function is used to convert the value of X (which must be between 1 and 255) to a single ASCII character. Thus CHR(16) will create a "CONTROL-P" and CHR(22) will create a "CONTROL-U". The CHR function may be used only on the PRINT statement and is useful for creating special control characters required for terminal control.

TAB (x) The TAB function can be used only in a PRINT statement. The value of X will cause the print mechanism to be positioned at column X. TAB(10) will cause a tab to column 10, TAB(50) will cause a tab to column 50. The value of the TAB function must be from 1 to 72.

USER The USER function is used to call a user defined assembly language subroutine.

OPERATORS

Symbols used to instruct the microcomputer to perform some operation are called operators. This version of BASIC includes arithmetic and relational operators.

ARITHMETIC OPERATORS — Five standard BASIC arithmetic operators are provided with this version of BASIC. The arithmetic operators are as follows:

- − Unary negation
- * Multiplication
- / Division
- + Addition
- − Subtraction

RELATIONAL OPERATORS — Standard BASIC relational operators are provided for comparing the values of integer expressions. The relational operators are as follows;

- = Equal
- <> Not equal
- < Less than
- > Greater than
- <= Less than or equal
- >= Greater than or equal

ERROR MESSAGES

The following error messages can be created by BASIC at any time:

ERROR CODE	MESSAGE DESCRIPTION
1	OVERSIZED VARIABLE. A TAB, CHR, ON or subscript value was greater than 255.
2	INPUT ERROR.
3	ILLEGAL CHARACTER OR VARIABLE. An illegal variable name of an invalid character was found during the evaluation of a mathematical expression.
4	NO ENDING " IN PRINT LITERAL. A missing quotation mark was detected in a print statement. There must be an even number of quotation marks on a print statement. The character (") cannot be output as a text character except by specifying CHR(34).
5	DIMENSIONING ERROR. Only two dimensions are allowed, and must be a value between 1 and 255. Once defined an array may not be defined again. Place all DIM statements at the start of the program, where they can not be accidentally executed a second time. All references to an array which is defined on a DIM statement must occur after the DIM statement has been executed.
6	ILLEGAL ARITHMETIC. The most common cause of "illegal arithmetic" is two arithmetic operators following each other, without a numeric value separating them. "2+ −3" is illegal arithmetic.
7	LINE NUMBER NOT FOUND. The "GOTO", "GOSUB" or "IF . . . THEN" line number does not exist in the program. If necessary a REM statement may be used as a dummy line to resolve a missing line number.
8	DIVIDE BY ZERO ATTEMPTED. You just can't do it! If there is no way to prevent it, place an "IF" statement prior to the divide and branch around the divide statement if a divide by zero might occur.
9	EXCESSIVE SUBROUTINE NESTING. The maximum number of subroutines that may be nested is 8. Generally when this occurs it is because a GOSUB is accidentally being executed, or somehow a return statement has not been executed.
10	RETURN without PRIOR GOSUB. You executed a RETURN statement without first executing a GOSUB. This is a no-no.
11	ILLEGAL VARIABLE. The name for the variable is not correct. An array may only be named with a single alphabetic character. A(1) is correct, A5(1) is not. A simple variable may be named either with a single alphabetic character, OR a single alphabetic character followed by a single numeric character. A, B0, C1 are legal names. 1A, BB, C3A are not legal names. This version of BASIC does not support character string variables (A$, B$ etc.)
12	UNRECOGNIZABLE STATEMENT. This first word in the statement was not a recognizable COMMAND or BASIC statement name; nor was it a variable (simple or array) name followed by an equal sign (=). This latter case is known as an implied LET statement.
13	PARENTHESIS ERROR. Either you have too many opening parenthesis "(" or too few closing ones ")". There must be exactly the

same number of opening and closing parenthesis in a programming statement.

14 MEMORY FULL. You just ran out of memory. Try to reduce the number of variables used in the program. If arrays are being used make sure that they are dimensioned to the exact size required. Reduce the amount of remarks and the amount of PRINT statements used. Look and see if any routines are similar enough in nature to be made a subroutine. Look for more efficient algorithms to solve your problem. Split the program up into several different programs. If all else fails, go buy some more memory!

15 SUBSCRIPT ERROR. The array was defined as a one dimensional array and the reference contains two dimensions, or vice-versa.

16 EXCESSIVE FOR LOOPS ACTIVE. The maximum number of nested FOR . . . NEXT loops is 8.

17 NEXT WITHOUT CORRESPONDING FOR. A NEXT statement has been found without a corresponding FOR statement. The named variable that occurs after the word "FOR" and after the word "NEXT" is used to identify corresponding "FOR" and "NEXT" statements.

18 MISNESTED FOR NEXT LOOPS. The computer has detected an improper nesting for multiple "FOR . . . NEXT" statements. See Figure 3 for an explanation of the proper and improper way to nest "FOR . . . NEXT" statements.

19 READ STATEMENT ERROR. Read statement was executed, and there is not enough data in the data buffer to satisfy the READ request.

20 ERROR IN ON STATEMENT. The expression when truncated to an integer value resulted in either a value less than one, or in a value that is greater than the number of statement numbers in the list. In the example below an error 20 will occur if the value of (X-Y) is less than 1 or greater than 5.

```
100 ON (X-Y) GOTO 1000,235,3000,20,35
```

21 INPUT OVERFLOW. More than 72 characters were typed on the line.

GRAMMAR REFERENCE SUMMARY

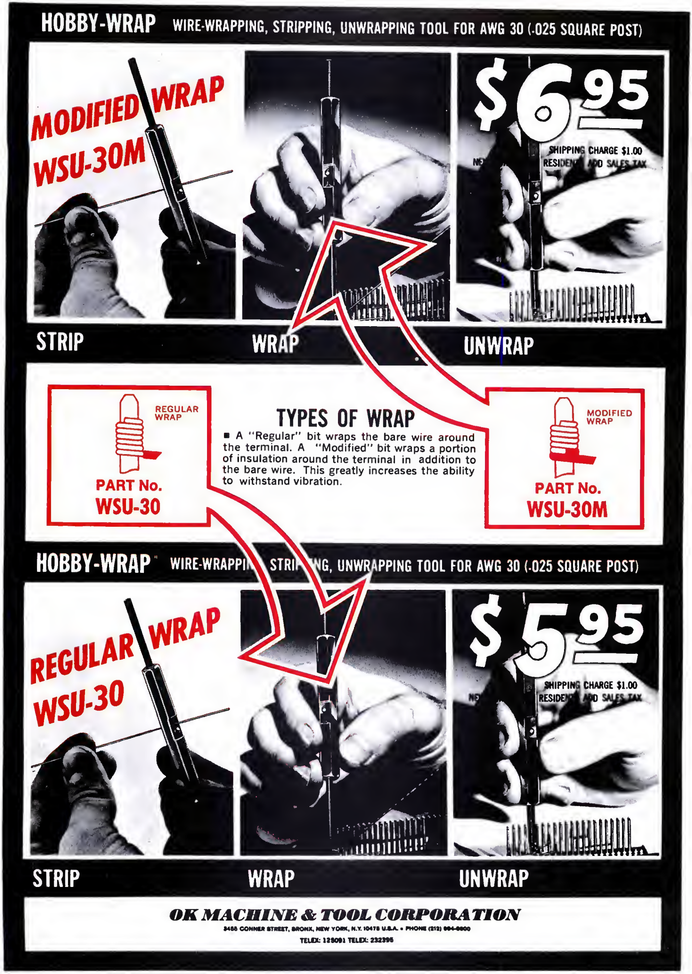
Figure 4, Quick definition of BASIC Statements, and figure 5, BASIC functions, provide a quick reference for using, Robert Uiterwyk's 4K 6800 BASIC Interpreter.

STATEMENT	DEFINITION	RELATED STATEMENT(S)
DATA	'STORES' DATA TO BE USED BY READ STATEMENT	READ RESTORE
DIM	DEFINES SIZE OF ARRAYS (1 or 2 dimensions are allowed.)	
END	DEFINES END OF PROGRAM	STOP
FOR	DEFINES START OF PROGRAMMING LOOP	NEXT
GOSUB	TRANSFERS CONTROL TO A SUBROUTINE	RETURN
GOTO	TRANSFERS CONTROL TO OTHER THAN THE NEXT SEQUENTIAL STATEMENT	
IF	CONDITIONAL TEST USUALLY USED TO TRANSFER CONTROL "IF"	THEN
INPUT	GET DATA FROM KEYBOARD OF ATTACHED TERMINAL	
LET	ASSIGNMENT OR CALCULATION STATEMENT	
NEXT	DEFINES END OF PROGRAMMING LOOP	FOR
ON	COMPUTED "GOTO" OR "GOSUB"	GOSUB GOTO
PRINT	PUT DATA TO PRINTER OR CRT OF ATTACHED TERMINAL	
READ	GET DATA FROM "DATA" STATEMENTS	DATA RESTORE
REM	PROGRAMMERS COMMENT	
RESTORE	RESETS THE DATA POINTER IN "DATA" STATEMENT	DATA READ
RETURN	DEFINES END OF SUBROUTINE — CAUSES CONTROL TO BE TRANSFERRED BACK TO STATEMENT IMMEDIATELY FOLLOWING THE GOSUB STATEMENT	GOSUB
STOP	DEFINES THE END OF THE PROGRAM: AND IDENTIFIES THE STATEMENT NUMBER OF THE STOP.	END

Figure 4. Quick definition of BASIC Statements

ABS( )	ABSOLUTE VALUE
CHR( )	CONVERSION OF VALUE TO A SINGLE CHARACTER
INT( )	INTEGER VALUE (TRUNCATES DECIMAL VALUE)
RND( )	RANDOM NUMBER GENERATOR; RETURNS VALUE FROM .000001 TO .999999
SGN( )	SIGN OF X; RETURNS A + 1,0, or − 1
TAB( )	USED IN PRINT STATEMENT ONLY: CAUSES A TAB TO THE SPECIFIED COLUMN
USER( )	CAUSES A CALL TO A USER DEFINED ASSEMBLY LANGUAGE SUBROUTINE.

Figure 5. BASIC Functions



CIRCLE INQUIRY NO. 41

HELP YOUR COMPUTER UNDERSTAND YOUR VOICE

by Owen F. Thomas

Talking computers these days make talking animals seem ordinary. But listening computers present a whole new array of problems that our new group of computer hobbyists — the "Thinker Tinkers" — might well solve. Or, at least, enjoy the tinkering.

The "Hear What I Mean" — HWIM — machine was built by Bolt, Beranek, and Newman Inc. and has served in pioneering studies of recognition vocabularies for computers. It can presently 'understand' 1097 words and three different male American speakers with an overall accuracy of 43 percent. It uses a 1967 vintage computer to process one second of speech in 1350 seconds.

Although a voice-recognition system using a Motorola 6800 microprocessor and accompanying equipment can do a spectrum analysis of one second of speech in 375 seconds, much experimentation and research into the tasks of recognition remain for "Thinker Tinkers" with which to tinker.

So far, HWIM has rather limited results in voice recognition. Each speaker *may* have to learn to control his voice very carefully and to provide his own voice-identification records before he can talk to the computer.

A speaker training himself to repeat his messages will find that a spectrum analyzer with a good display is a useful tool. Spectrum analysis measures fluctuating phenomena and describes the amount of fluctuation. Figure 1 shows a general diagram of a spectrum analyzer. Such an analyzer can measure effects of attempted voice control and allow refinement until the fluctuations are satisfactory. This is computer feedback applied to control of speech or singing.

For example, a singer uses the fluctuations of air pressure in his throat to produce pleasant sounds. How does he control the fluctuations of air pressure?

Some people are natural-born singers, but most require the services of a voice teacher. The voice teacher listens and recommends breath controls and exercises to the student. The voice teacher is performing a spectrum analysis with his ear and brain. He knows what voice spectrum is pleasant and has some idea of how to produce it.

A microphone attached to a preamplifier provides an electrical sample of the pressure fluctuations for spectrum analysis. The transducer in Figure 1 becomes a microphone for the voice student. The student sings into the microphone and the computer performs a spectrum analysis for display. Student and teacher learn

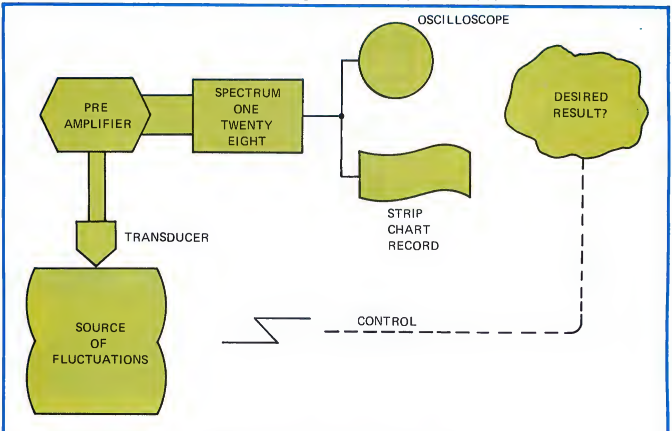


Figure 1. Application of spectrum analyzer.

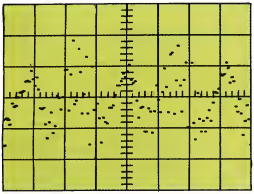


Figure 2. Vowel "A" fluctuations as in "pay".

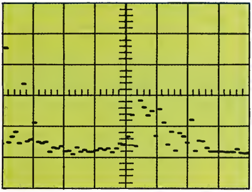


Figure 3. Vowel "A" spectrum as in "pay".

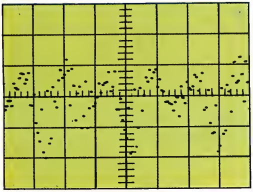


Figure 4. Vowel "E" fluctuations as in "pea".

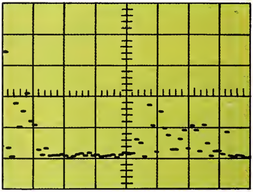


Figure 5. Vowel "E" spectrum as in "pea".

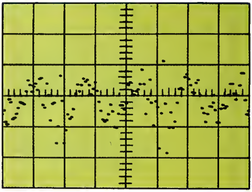


Figure 6. Vowel "I" fluctuations as in "pie".

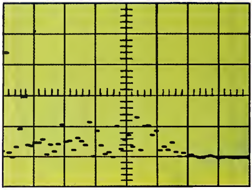


Figure 7. Vowel "I" spectrum as in "pie".

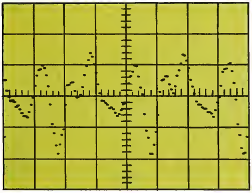


Figure 8. Vowel "O" fluctuations as in "poe".

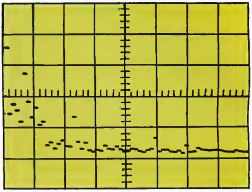


Figure 11. Vowel "U" spectrum as in "you".

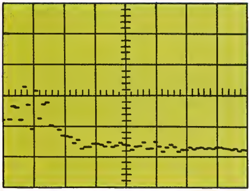


Figure 9. Vowel "O" spectrum as in "poe".

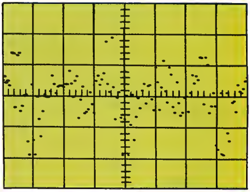


Figure 12. Repeat of vowel "A" fluctuations as in "pay".

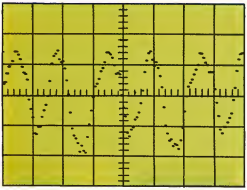


Figure 10. Vowel "U" fluctuations as in "you".

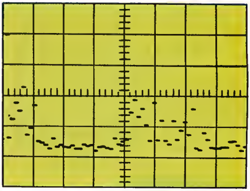


Figure 13. Repeat of vowel "A" spectrum as in "pay".

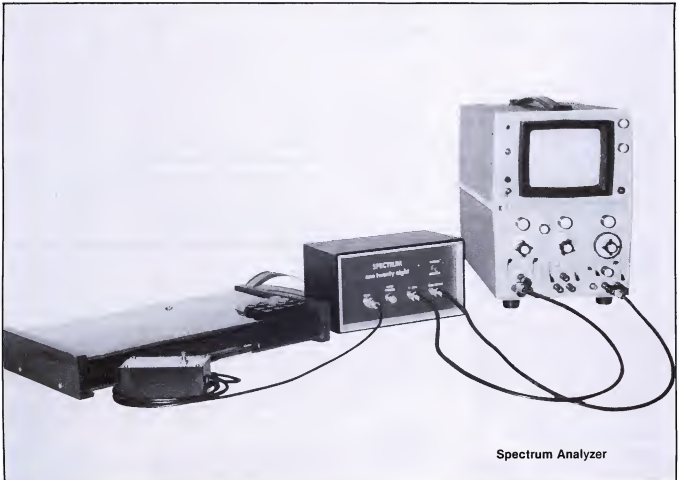
some interesting lessons when they can both see and hear the result of their attempts to control sounds and to reproduce them exactly. This is feedback applied to control sounds and their exact reproduction, and feedback applied to control of the body (or biofeedback) in a learning situation.

SPECTRUM ANALYZER DESCRIPTION

A spectrum analyzer measures the amount of sound fluctuations and describes their character. Many commercial models have a great variety of sophisticated uses. The technique I used, as described here, is a purely digital one known as the Fast Fourier Transform. The programming theory is complicated, but the operation is easily understood when in a PROM. I used a new system called SPECTRUM-128, which employs a Motorola 6800 microcomputer on a board with a PROM.

Fluctuation means "a moving back and forth or up and down; rising and falling, as of waves." One can interpret this in two valid ways when describing a phenomenon for spectrum analysis. The most common describes the motion as of a body in the ocean at a fixed latitude and longitude as time progresses. The second describes variations with distance at a fixed time, as seen in, say a photograph of the ocean against a breakwater. The spectrum analyzer used here sampled an electrical signal at evenly spaced intervals of time. The electrical signal is generated in an electrical device or derived from some fluctuating source by means of a transducer and preamplifier. A familiar form of fluctuation is the sine wave produced by a resonant device, such as a crystal in an oscillator circuit.

Fluctuations are measured in the spectrum analyzer by comparison with sine wave reference standards. The standards comprise a set of sine waves ranging from



Spectrum Analyzer

zero frequency, or d.c., to an upper frequency limit imposed by the number of the digital samples taken from the fluctuating source. The upper frequency limit is that frequency which would go through a complete cycle while two samples are taken. The standard sine waves are in digital numbers representing the result that would be obtained by sampling an integer number of sine wave cycles. SPECTRUM-128 samples the fluctuations 128 times. So the maximum number of integer cycles that could be sampled is 64. A fluctuation occurring 64 times during the sampling process corresponds to the highest rate of fluctuations that can be correctly measured. For all digital systems, the highest frequency that can be correctly measured, known as the aliasing frequency, is half of the sampling frequency. The sampled fluctuation is compared to the standards to determine its correlation.

If the sampled fluctuation is a sine wave with a frequency of "X" cycles during the sampling process, it will correlate exactly with the stored sample of "X" cycles when "X" is an integer. The spectrum analyzer then reports that there is power in the "X" cycle result exclusively. When "X" is not an integer, the major correlation will be with the stored reference closest to "X" cycles, but there will also be some correlation to many nearby frequencies of the reference set. The spectrum analyzer will then report that there is power at nearby frequencies. When the fluctuation is not a sine wave, the spectrum analyzer determines what collection of sine waves can be used to best describe the fluctuation. For a precise mathematical description of all these relationships, one must study the theory of Fourier analysis.

The spectrum analysis results in a measurement of how much power is in every frequency relative to the maximum amount allowable in a single sine wave fluctuation sampled by the digital sampling input to SPECTRUM-128. The measure of relative power is in decibels, the standard used by engineers. This measure is closely related to psychological responses. Three decibels correspond to the change of sound power which is perceived as a noticeable step of power. An increase of three decibels increases the sound pressure to 1.41 times the former pressure; a decrease of three decibels decreases the sound pressure to 0.71 times the former pressure. The increase of pressure corresponds to double the power; the decrease of pressure corresponds to half the power.

For all digital systems, the highest frequency which can be correctly measured, known as the aliasing frequency, is half of the sampling frequency.

SPECTRUM-128 presents the sampled data or the spectral results in analog form for easy and fast display. Pictures of results displayed on an oscilloscope illustrate the concepts. The display presents 128 values on the oscilloscope, then repeats the full display. When the 128 values represent the samples from the fluctuating source, they are referred to as a *frame of data*. When the 128 values represent results of spectrum analysis, only 64 separate frequency measurements occur, and the oscilloscope speed shows only 64 values, the spectrum corresponding to the frame of data.

There are half as many frequency measurements as there are samples of the fluctuations.

In describing spectrum analysis, we discussed how many cycles of fluctuations were compared to the reference, but we made no mention of the frequency. The rate of conversion from fluctuating electrical to digital input numbers determines the frequency scale. If each conversion occurs in 1/128th of a second, the entire data frame is sampled in one second. Then we could speak of the cycles as cycles per second (CPS). We would have one integral value of the reference sine wave for each CPS from 0 through 64. This relation of number of samples to frequency measurements is typical of digital systems: There are half as many frequency measurements as there are samples of the fluctuations.

The frequency increment between measurements, often called the bin width, is the aliasing frequency divided by the number of frequency measurements.

For the examples used in the illustrations, conversions were made at 8000 per second to select an aliasing frequency (the maximum frequency that can be measured correctly) of 4000 Hz. The frequency increment between measurements, often called the bin width, is the aliasing frequency divided by the number of frequency measurements. (The three important relationships of spectrum analysis have now been stated; see Table I for a convenient summary.) There are only 64 measurements in the examples, so there is only one measurement for each 4000/64 or 62.5 Hz.

To state this result another way, the entire data frame was sampled in 128/8000th of a second. The spectrum output results are in terms of cycles per 128/8000 or 0.016 second. A sine wave of 62.5 Hz will require 1/62.5 or 0.016 second to go through one cycle while the analyzer samples one frame of data. Thus, the spectrum

A STORY IN THREE ACTS

ACT 1: Our story begins with the ACT-I terminal—the world's first Affordable Computer Terminal. The ACT-I is an exceptionally practical interface between man and machine for any computer system which communicates over a serial ASCII link. Whether querying a microprocessor based system or time-sharing on a major computer net, the ACT-I is the most economical method of alphanumeric communication at data rates from 110 baud all the way to 9600 baud. The ACT-I video computer terminal manages a 1024 character display memory organized as 16 lines of 64 characters chosen from the standard upper case ASCII set. Receipt of more than 64 characters on a line or the 'CR' code initiates a scroll operation. The entire screen may be locally cleared at any time by depressing the 'CLEAR' key.

I/O SPECIFICATIONS
(JUMPER SELECTABLE):

DATA RATE: 110, 300, 600, 1200, 2400, 4800, 9500 BAUD

PARITY: odd, even, or none

STOP BITS: 1 or 2

LOGIC LEVELS: RS232, TTL, or 20 ma loop

PRICE: $400

ACT 2: The plot thickens. For remote communication to a central processor MICRO-TERM introduces the ACT-II. The ACT-II includes all of the desirable features of the ACT-I with the important addition of an integral originate—only 300 baud modem and acoustic coupler for a standard telephone handset. The ACT-II (without monitor) slips easily into a briefcase (4x14x11) and readily commutes with you.

The ACT-II's modem features 5 stages of active filtering as well as one passive stage to achieve the lowest possible error rates despite the noises present on Ma Bell's lines.

Want true CPU power for low cost? Investigate the time-sharing systems in your area; the ACT-II can be your key to the tremendous libraries of debugged, documented, software which are available on these dial-up systems.

PRICE: $550.

ACT 3: Not to be upstaged by its exciting predecessors, the ACT-III performs with state of the art elegance and versatility. The ACT-III includes switch selectable display formats: 24 lines of 80 characters; 48 lines of 40 characters; or 96 lines of 20 characters. Transmission is also switch selectable between three modes: character, line or page at a time mode. The PRINT key sends the contents of the 1920 character display memory out an RS232C printer port at rates up to 9600 baud. For optimum efficiency, trailing spaces on any display line are excluded from transmission and of course the printer rate is independently switch selectable.

Full cursor control, direct cursor addressing, protected data fields, and video inversion are all standard encodeable functions. Convenience features such as a video monitor AC power outlet and a switch to initiate a comprehensive terminal self test are available on the cabinet rear. The ACT-III is the most complete video terminal available at a price far below that of the competition, smart and dumb alike.

PRICE: $700.

GENERAL INFORMATION

All MICRO-TERM products are fully assembled, tested and guaranteed for 90 days.

The MICRO-TERM product line is available from stock at discriminating computer stores or may be purchased directly from the factory (30-45 day delivery). Prices are F.O.B. St. Louis, Mo. excluding video monitors. Optional high resolution video monitors are available from the factory beginning at $125.00.

BankAmericard and Master Charge accepted.

MTI

MICRO-TERM INC.
P.O. BOX 9387
ST. LOUIS, MO 63117

analyzer reports power in the "X" cycle result when the fluctuations are "X" times 62.5 Hz.

The abbreviation Hz, standard designation for cycles per second, honors Heinrich Hertz, a German Physicist who made major contributions to understanding electromagnetic fluctuations. Maybe some day the abbreviation "T" will represent a unit of speech intelligibility in honor of the "Thinker Tinkers" and their success with voice-commanded computers!

SPECTRUM ANALYZER EXAMPLES

I used myself as a subject for the data analyzed in even-numbered Figures 2 to 12. The oscilloscope was adjusted to show the entire data frame in each instance. The time base of the oscilloscope does not matter so much as the sampling interval. These samples represent 0.016 second of speech or 0.002 second per major division of the display. It is very difficult to control one's voice well enough to see such waveforms with an analog input to the trigger of the oscilloscope. With sampled digital data and a computer-synchronized trigger, the display is easy to read.

This display hides a fact that can deceive if ignored: Try listening to the sampled sound one time through an audio system output for 0.016 second. You will hear a very short beep and no more. Now try a program loop which does the output again as soon as it finishes. You will hear a steady tone that reminds you of the oral vowel. Actual speech is composed of a changing spectrum. The sampled data frame has only one spectrum which goes on, and on, and on . . . Many consecutive samples of speech must be analyzed to allow the computer to understand changing spectra. This subject belongs to future articles.

The sampling rate of 8000 per second gives a spectrum from 0 to 4000 Hz. This adequately covers the highest frequency of the vowel sounds I produced. Remember that the digital technique will produce wrong answers if the sampled frequency is so slow that there are fewer than two samples per cycle. With all these choices, the spectrum of the vowels is presented in odd-numbered Figures 3 to 13 with the oscilloscope speed adjusted in each instance to present the 64 independent frequency measurements. The major divisions of the 4000 Hz frequency range occur 500 Hz apart. The vertical divisions occur 12 decibels apart, meaning that a power change of a factor of 16 suffices to cause a measurement change of one vertical division.

The twelve figures show data frames from the five vowels, with each data frame followed by its spectrum. The vowel "A" is sampled twice to show the type of variability that occurs. The first data frame in Figure 2 was taken about ten minutes before the data frame in Figure 12. The data frames do not look very similar, but the corresponding spectra in Figures 3 and 13 do show a strong similarity. Each spectrum has a major component at 312 Hz, a second strongest component near 2250 Hz, and third and fourth strongest components at 2500 Hz and 3062 Hz.

Compare the two versions of the spoken vowel "A" with the data frame from that for "E" shown in Figure 4 and its spectrum in Figure 5. Note the similarity of the sampled frames of data. The spectrum of "E" has a first maximum at 187 Hz, followed closely by another at 375 Hz. This may be a dual tone compared to the single tone of "A" at 312 Hz. Six more large components of "E" occur at 2187 Hz, 2375 Hz, 2562 Hz, 3062 Hz, 3250 Hz,

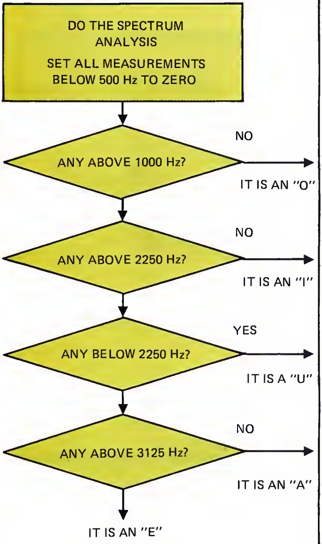


Figure 14. Flow chart for vowel recognition.

Table I. Basic Relationships of Spectrum Analyzer Control Variables

The aliasing frequency (F_A) is half of the sampling frequency (F_S): $F_A = F_S/2$

There are half as many frequency measurements (M) as there are samples (N) of the fluctuations:

$$M = N/2$$

The bin width (B) is the aliasing frequency (F_A) divided by the number of frequency measurements (M):

$$B = F_A/M$$

By substitution, also:

$$B = 2F_A/N$$

$$B = F_S/N$$

and 3687 Hz. This very complicated spectrum has frequencies approaching the aliasing frequency and many more components than the spectrum of "A". I need to analyze a large number of spectra in various states of my well being to determine whether I have sufficient control to maintain recognizable differences between "A" and "E". Then I will have to produce a computer algorithm capable of recognizing the distinguishing differences. Now one can sympathize with the engineer of HWIM who has spent five years with only three male American speakers!

Figure 6 shows the sample of fluctuations of the spoken vowel "I", with its spectrum in Figure 7. The character of the data frame is not clearly unique, and the major component of the spectrum is again at 312 Hz. The spectrum differs between 321 Hz and 2000 Hz, with components at 937 Hz, 1375 Hz, 1875 Hz, and 2187 Hz, where there were none for vowel sounds "A" or "E". This clue suffices for easy computer recognition of the vowel. More analyses will probably ensure that the difference is consistent. Measurements have appeared near 312 Hz for each vowel. Maybe 312 Hz is the basic frequency of my voice and should be ignored in distinguishing vowels.

Figure 8 shows the sampled sound for the vowel "O", with its spectrum in Figure 9. The basic frequency of 312 Hz appears with one or maybe two low-power frequencies at 500 Hz and 687 Hz. Some higher frequencies are at least 20 decibels lower. This spectral simplicity makes it easy to distinguish an "O" from the previous vowels. Note that the sampled data frame is much smoother. The reduced high-frequency content produces a smoother fluctuation. The vowel might be distinguished from "A" "E", and "I" by the sampled data alone, without a spectrum analyzer.

Figure 10 shows the sampled data frame from the vowel "U", with its spectrum in Figure 11. The smooth waveform shows that a spectrum analysis is needed to distinguish "U" from "O". The spectrum shows clear components at 1250 Hz, 2437 Hz, and 2937 Hz in addition to 375 Hz. The smooth fluctuations with higher frequencies present suggest that all frequencies are harmonics. This suggestion is not apparent from what has been shown here, but it is apparent after experimentation with spectrum analysis of many different fluctuations. This harmonic nature of "U" may provide a clue for recognition of the vowel. The speaker's voice control will need further understanding before the method can be developed and tested.

Table II organizes the variety of measurements made with the vowels across the top and the 64 frequency bins down the left side. Below each vowel, an X marks a frequency observed for that vowel. Using this table of measurements, one can systematically observe these differences and can form a theory of how to differentiate between the vowels. Several systems might be tried. The simplest is probably best.

Figure 14 shows a flow diagram of a possible scheme for distinguishing between the vowels I spoke. It is easy to test the flow chart by using it to analyze the spectra in Figures 3 to 13.

This is all that I have to offer hobbyists of voice-commanded computers, to date. I hope experts in other fields will make an effort to explain their studies in simple terms. I am sure that physiologists know much pertinent information not included in this article. Linguists have studied the subject also. The skills and time of "Thinker Tinkers" with stimulation and assistance can produce exciting results.

TABLE II. SUMMARY OF VOWEL FREQUENCIES

Hz	A	E	I	O	U
62.5					
125					
187.5		X			
250					
312.5	X		X	X	
375		X			X
437.5					
500				X	
562.5					
625					
687.5				X	
750					
812.5					
875					
937.5			X		
1000					
1062.5					
1125					
1187.5					
1250					X
1312.5					
1375			X		
1437.5					
1500					
1562.5					
1625					
1687.5					
1750					
1812.5					
1875			X		
1937.5					
2000					
2062.5					
2125					
2187.5		X	X		
2250	X				
2312.5					
2375		X			
2437.5					X
2500	X				
2562.5		X			
2625					
2687.5					
2750					
2812.5					
2875					
2937.5					X
3000					

TABLE II. (Continued)

Hz	A	E	I	O	U
3062.5	X	X			
3125					
3187.5					
3250		X			
3312.5					
3375					
3437.5					
3500					
3562.5					
3625					
3687.5		X			
3750					
3812.5					
3875					
3937.5					
4000					

PRODUCT PREVIEW

MULTI-TYME™

System Employs 880 Microcomputer for Timekeeping and Security Operations

by Michael di Meo

NO TIME CLOCKS

"MULTI-TYME™" is a computerized system which enables a company, plant or institution to initiate and administer a policy of flexible working hours for its employees. The computerized input provides automatic feed of all time and attendance data to the payroll accounting system.

SECURITY SYSTEM

Additionally the same installation processes security information from ingress and egress ports of the plant, from fire and flood detection equipment, regulates temperature conditions and monitors power failures.

Cardkey Systems, a division of Greer Hydraulics, Inc. designed this system around two of the company's products, the Interrogator 880 microcomputer system and the company's standard Cardkey Securiti-Card® latching device. The peripherals were supplied by Digital Equipment Corporation.

HISTORY OF THE CONCEPT

Time and Motion Studies in a number of industrial countries have revealed a steadily declining rate of growth in worker productivity. This can be partially alleviated by management experimentation in flexible working time where employees set their own work hours within limits established by the employer.

The first flexible working hours system was introduced only nine years ago in a Messerschmitt plant in Munich, West Germany in response to traffic congestion problems during peak hours. The aerospace firm permitted its 2000 employees to stretch out their arrival and departures over a prescribed band of time in the morning and evening, start and finish work at their discretion as

Figure 1. MULTI-TYME™ monitors and operates both flexible and fixed working time systems in almost any installation or facility—government, business, industrial, financial, institutional—without time clocks, time cards or other conventional timekeeping equipment. The system includes video displays, hard copy printer (right) and a processor (left) which automatically feeds all time and attendance information directly into the payroll system.

Introducing the Micropolis MetaFloppy.™ The first system that actually combines the high-capacity storage of an 8″ floppy with the low cost and convenience of a 5¼″ format.

Metafloppy goes far beyond any ordinary floppy. Giving you the lowest obtainable cost per thousand bytes of floppy disk storage. From anyone. Or anywhere.

In fact, there's really no comparison. An ordinary 5¼″ floppy provides just 70K (or so) bytes of storage. Not nearly enough for meaningful work.

Metafloppy, instead, packs each disk with a whopping 315K bytes of storage! The true equivalent of any typical 8″ floppy. And over four times the capacity of a typical 5¼″ floppy. (We call it "quad" density.)

Best of all, Micropolis delivers everything you need—the drive, S-100 controller, interface cable, power supply, even extended BASIC software—all for an unbeatable $1095.

Or save $150 and buy a Micropolis "double" density drive instead. You get the same complete package but with 143K bytes of storage per disk. That's still twice the capacity of a typical 5¼″ floppy. And twice the buy.

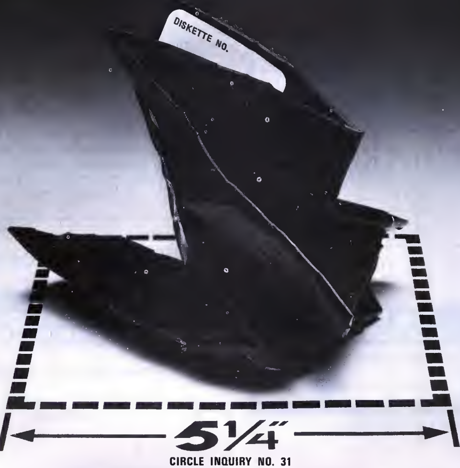
For maximum convenience—and savings—both densities are also available in dual drive models.

But then, at Micropolis our goal is to give you twice the bytes per buck. And today, it's quite literally the very least we can do.

MICROPOLIS™

In the U.S., please contact:
Micropolis Corporation, 9017 Reseda Blvd.
Northridge, California 91324 (213) 349-2328

It's one thing to get an 8″ floppy into a 5¼″ format. It's another thing to do it without spending a wad.



CIRCLE INQUIRY NO. 31

long as they completed the total number of hours required for a total pay period. All workers, however, must be present during so-called "core times," usually a two- or three-hour period before and after lunch break.

Traffic conditions improved and some unexpected side-effects appeared. Overtime declined by 50 percent, absenteeism dropped 40 percent, employee morale rose, reflected by diminished employee turnover and reduced tardiness.

In the intervening years the same results were achieved virtually everywhere the flexible hours system was introduced.

The principle obstacle to widespread introduction of the flexible hours concept in the United States was caused by the limitations of timekeeping equipment which necessitated manual transcription of recorded time data. Inexpensive computerization changed the picture.

The MULTI-TYME™ system provides the answer. It is the first timekeeping system which can simultaneously keep track of both flexible and fixed working time environments and has output capabilities to interface with automated payroll systems. MULTI-TYME™ electronically records and maintains a record of all employee entry and exit times from data received from the badge readers. The data are processed for routing through the 880 to the storage files and/or video display.

The processor is programmed with the cardholder's personnel and payroll information. His in/out activity and total hours to the minute are accumulated in the file and sorted, the resulting data on mag tape become the entry to the company's payroll accounting system.

Card transactions during invalid times—late arrivals, early departures and other periods monitored for a variable working hours environment—are recorded as exceptions and can be displayed at the time of occurrence.

One or more CRTs may be used to examine data in the employee file. The CRTs can be used in an interactive mode to make adjustments in the record for such changes as sick time, vacation and holidays.

Employees may also access the system to obtain work record information, but this display operates in the display mode only. The employee has no ability to modify the data.

The printer terminal is used to generate printed records for tax information and management use. In addition to weekly attendance recording, the MULTI-TYME™ installation functions as an instant source of identification for any available group within the work force and can be used to eliminate imbalances created by absences and tardiness where work pileup or unnecessary idle time would result.

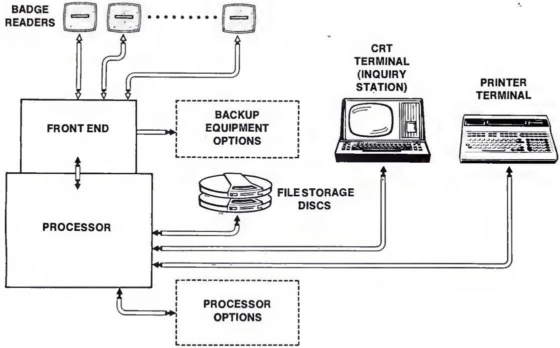


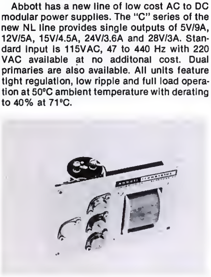
Figure 3. Typical MULTI-TYME™ Hardware Configuration.

CIRCLE INQUIRY NO. 43

NEW PRODUCTS

NEW POWER MODULE

Abbott has a new line of low cost AC to DC modular power supplies. The "C" series of the new NL line provides single outputs of 5V/9A, 12V/5A, 15V/4.5A, 24V/3.6A and 28V/3A. Standard input is 115VAC, 47 to 440 Hz with 220 VAC available at no additonal cost. Dual primaries are also available. All units feature tight regulation, low ripple and full load operation at 50°C ambient temperature with derating to 40% at 71°C.



Overvoltage protection is standard on 5V outputs and available as an optional feature on the higher voltages. Case size in only 7 x 4⅞ x 2¾ inches with mounting on three surfaces. High quality components are used throughout with conservative design margins to assure high reliability and long life under worst case operating conditions.

The NL line also includes single, dual and triple output models with power ratings from 15 to 170 watts. Send for Abbott's new 1976-77 Industrial Power Supply Catalog for complete details on this and other lines of power modules.

Price: $61.00 (1-24 pieces) Delivery: Normally from stock.

For further information, contact Abbott Industrial Products Division, 639 S. Glenwood Pl., Burbank, CA 91506, Tel. (213)841-2510, Telex 69-6282.

CIRCLE INQUIRY NO. 115

VIDEO GAME CHIP FOR BLACK—AND—WHITE TV

A new game chip intended for the black and white TV market is now available from National Semiconductor Corporation. The MM5789 is an IC that has tennis, hockey and handball in a format similar to the MM57100, National's color video game chip.

The main difference between the MM5789 and the MM57100, other than color, is in the hockey game. In the MM57100, downfield players engage in random blocking to protect each player's goal. With the MM5789, the downfield players are controlled by the player's paddle.

The game chips may also be integrated directly into a TV set without going through the antenna, requiring only two chips instead of three. The MM5789 generates the composite video, and the MM53104 operates directly with a 3.58 MHz crystal. To accomplish this, the video signal is inserted into the television set at a point after the video detector and the audio are switched into the sound section of the set. In this way, an ordinary black and white TV set may be modified to include games by adding a multipole switch power supply, game chipset and components, and a push-button switch to select the game.

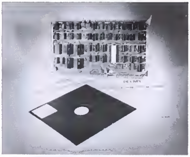
An external RC network, consisting of a fixed capacitor and a variable resistor, gives the vertical paddle positioning. Moving to the top or bottom boundary and pressing the reset button or an external button will change the paddle size. The games are selected in sequence by pushing a button. The score, presented numerically on the TV screen, is blanked automatically when the ball is put into play.

For further information, contact National Semiconductor, 2900 Semiconductor Drive, Santa Clara, CA 95051, Tel. (408)737-5000.

CIRCLE INQUIRY NO. 116

RELMS Z80 SYSTEM ADAPTOR MODULE ENABLES MDS-800 TO SUPPORT AND DEVELOP 8080 AND Z80 HARDWARE/SOFTWARE

For designers wanting the additional capability of the Zilog Z80 but tied to MDS-800 hardware and 8080 software, Relational Memory Systems, Inc. (RELMS) announces the Z80 System Adaptor Module, Z80-SAM. Completely hardware and software compatible with the 8080, 8080A, 8085 and Z80 Microprocessors, the Z80-SAM enables an MDS-800 to support and develop both 8080 and Zilog Z80 software for a fraction of a new Development System's cost.



The Z80-SAM contains a single board and associated software and firmware. The SAM Microcomputer Board supplants the corresponding MDS-800 board.

Besides the hardware board, Z80-SAM System Monitor PROM firmware replaces corresponding MDS-800 ROM firmware (on Monitor PROM Board). Software consisting of a 16K DOS Assembler is added to existing MDS software. Software will be available shortly to support ICOM Diskette systems with the MDS-800.

Most notably, the Z80-SAM extends the useful life of the capital investment 8080 users have in their MDS-800 System while enabling the user to utilize the faster, more efficient Z80 microprocessor in future hardware/software development.

In additon, the SAM Z80 Assembler facilitates software development in that it operates four times as fast as the 8080 Assembler on the MDS-800. Moreover, the user can ease program development by patching Z80 code into existing 8080 code via the Z80-SAM.

Enhanced debugging capability is afforded by hardware features such as display LED's and single cycle switch which allow the user to freeze the MDS-800 data bus, examine the bus contents,and single-step the program.

A more powerful set of Monitor PROM commands improves both program debug and development capability. The monitor permits a masked 8-hexadecimal digit string memory search. It displays all Z80 registers and enables a specified memory-word or register bit to be set, cleared or displayed.

To eliminate the chore of entering repeatedly by hand a set of console commands, the Monitor PROM permits the sequence of commands to be written into memory and later retrieved when needed and executed.

Central to the expanded capability of the Z80-SAM is the Z80 Microcomputer Board. A quality of the Z80 microcomputer which affords significantly increased programming efficiency while reducing effort is its large 158-command instruction set.

The instructions permit combinations of addressing modes in a single instruction and "block moves and searches" of up to 65K of data with one instruction. The instructions permit relative, indexed, and modified page zero addressing.

Beyond the instruction set, the microcomputer contains additional hardware which facilitates the programming effort. Two 16-bit index registers enable index addressing while an extra 8-bit accumulator permits 16-bit arithmetic. Moreover, twice as many general purpose registers are available to the user as in the 8080.

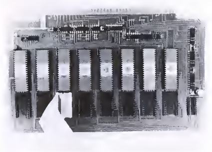
Price and Delivery: The Z80-SAM is priced at $1495 in single-unit quantity and includes the Z80 Microcomputer Board, Monitor ROM Board, and Z80 SAM Assembler on diskette. OEM quantity discounts are available. Delivery is immediate from the factory.

For further information, contact Douglas B. Kelley, Director, Sales/Marketing, Relational Memory Systems, Inc. (RELMS), P.O.Box 6719, Santa Clara, CA 95150, Tel. (408)248-6356.

CIRCLE INQUIRY NO. 117

9620 INTERFACE MODULE WITH 16 PARALLEL I/O PORTS

The 9620 is a parallel interface module specifically designed for compatibility with the M6800 Microprocessor Bus. It is pin and outline compatible with the Motorola EXORciser*, Micromodule*, the MEK6800D1 and MEK6800D2 Evaluation Kits, and other industry standard cards. It features full address decoding and fully buffered data, address and control lines. This module utilizes 8 MC6820 Peripheral Interface Adapters mounted in sockets, each with its own flat cable connector. Sixteen parallel I/O ports are therefore provided on a single card.



The 9620 occupies 32 sequential memory addresses. The 16 PERIPHERAL DATA/DATA DIRECTION REGISTERS and the 16 CONTROL REGISTERS are sequentially arranged to permit the use of a very tight polling loop in interrupt-driven systems. This arrangement also allows indexed addressing to improve coding efficiency for multichannel I/O systems.

The 9620 is the newest member of a family of M6800 Support Modules. All cards of the Family are 6.05 inches by 9.75 inches and utilize a 43-pin dual readout connector with 0.15625 inch pin spacing.

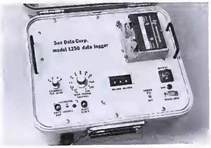
The 9620 is priced at $375 in single quantities and $225 in lots of 100. Delivery is two to four weeks from factory stock. For further information contact CREATIVE MICRO SYSTEMS, 5231 Loyola Ave., Westminster, CA 92683; phone (714) 892-2859.

*Trade Mark of Motorola, Inc.

CIRCLE INQUIRY NO. 118

Portable Data Logger Scans 8 Times Faster

A new series of low-cost, lightweight, all-weather battery-operated data acquistion systems with operating speeds up to 32 samples per second and storage capacities exceeding 10 megabits on a standard 300-foot Phillips-type digital cassette.



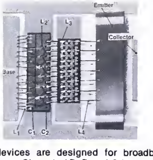
High scanning rates are attributable to a unique 8-phase driver for the high-resolution stepping motor in the incremental tape recorder. The new recorder allows an 8-channel scan interval of 250 milliseconds as opposed to the 2-second scan interval of other portable loggers currently on the market. On a single battery charge and without changing cassette, the Sea Data unit can record 536,000 12-bit data words, plus 67,000 36-bit headers (including elapsed time).

For further information, contact Sea Data Corporation, 153 California Street, Newton, Massachusetts 02158; Telephone (617) 244-3216.

CIRCLE INQUIRY NO. 119

High Technology RF Transistors Increase Output Power at UHF

A series of new RF power transistors that extends RF power output capabilities to 80 Watts in the 100 to 500 megahertz range has been introduced by Motorola.



The devices are designed for broadband operation as Class A, AB, B and C transmitter amplifiers in UHF communications equipment operating from a 12-28 Volt power supply. One primary application is expected to be in Military Aircraft Radios.

To achieve the reliability required for military applications, an all-gold metallization system is employed for all devices. Gold is used for the top metal of the transistor, for the associated MOS capacitors, for the bonding wires, as well as for package plating. The reliability advantage achieved results from the elimination of "aluminum migration" and corrosion due to contact of dissimilar metals.

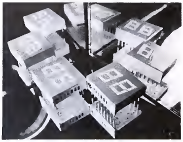
The new devices are available from OEM stock and from Motorola distributors.

For further information, contact Motorola Semiconductor Products, Inc., P.O. Box 20912, Phoenix, Arizona 85036, Phone 244-6900.

CIRCLE INQUIRY NO. 120

Dual Seven-Segment Displays

The .3 inch red, two-digit displays are designed especially for Citizen Band channel indicators, electronic games, industrial instrumentation, television set channel indicators and for appliances such as microwave ovens, clothes dryers and washers.



The TIL807 display has a common anode; the TIL808 has a common cathode. Besides being low in cost, they feature high brightness, typically 500 μcd per segment at 20mA.

The displays have a rugged, lead frame construction with bottom pins for an easy mounting, plug-in package. Pin spacing is .08 inch for insertion in mounting hole rows on .5 inch centers. Besides rugged construction, these devices have wide viewing angle.

The package is .6 inch high by .7 inch wide and has two .3 inch high characters, providing compact packaging with high reliability.

Prices for either type are $3.84 each in up to 100 quantities and $2.88 each in quantities above 100 to 999.

For further information, contact Texas Instruments Incorporated, Inquiry Answering Service, P.O. Box 5012, M/S 308 (Attn: TIL807, 808), Dallas, Texas 75222.

CIRCLE INQUIRY NO. 121

HEX Breadboards Available for PDP-II & PDP-8/A Users

The availability of a complete line of breadboards in the HEX pattern, designed for compatibility with Digital Equipment Corporation's PDP-II & 8/A minicomputers, is being announced by Douglas Electronics.

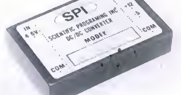
A manufacturer of PDP-8 compatible breadboards and accessories, Douglas is expanding its lines to meet a growing demand on the part of mini users for products which will facilitate the development and expansion of mini-based systems.

The boards offered are all FR-4 glass epoxy with electro-plated solder circuits and gold connector tabs and come in a variety of configurations and options which include extender boards with sockets, wire wrap boards, breadboards for LSI and SSI use, and I/O transfers. The entire series is now available from stock at Douglas Electronics, Inc., 718 Marina Blvd., San Leandro, CA 94577.

CIRCLE INQUIRY NO. 122

Triple-Output DC/DC Converters For Microprocessors

Scientific Programming Inc., is introducing a new series of low-cost but high-performance miniature DC/DC converters for the microprocessor and semiconductor fields.



The new converters are unusual in that they provide three output voltages (typically +12 V, +5V, and −5V) at high currents to meet the power needs of virtually any microprocessor or RAM device. The converters are thought to be the only ones commercially available that provide three regulated outputs with greater than 75% efficiency.

Recommended use for the converters includes powering microprocessor systems such as the 8080 family, powering EPROMs such as the 2708's, and powering the popular new 16K x 1 dynamic RAMs.

Besides being physically small and low in cost, the new converters have a high efficiency of over 75% at full load. The outputs are regulated for input ranges from 4 to 6V, a range which enables operation from 4 cells in battery-operated applications. Idle current for the converters is only 15 mA, which is equivalent to 300 hours of continuous operation from typical "D" size batteries.

Physically, the converters are encapsulated in rigid cases 2.25" x 3.25" x 0.45" in size. The small size suits the converters to mounting on standard printed circuit cards.

The converters are available in eight models with a range of output voltages and currents. The most commonly used model provides +5V at 250 mA, +12V at 80 mA, and −5V at 80 mA. Output voltage regulation is ±5% for the input range from 4 to 6V. Other output voltages such as +5V, +15V, and −5V are also available.

A two-output series offering such outputs as +12V and −5V or +15V and −15V is included in the line.

All converters can be special ordered with the following options: (a) 6V AC input instead of unregulated DC, (b) 80% efficiency instead of the standard 75%, (c) power strobing (TTL and CMOS compatible on/off control for each output).

Prices of the converters range from $29.95 to $59.95, depending on quantity. Delivery is from stock to 4 weeks, depending on model. For more information, contact: Scientific Programming Inc., 1499 Bayshore Highway, Burlingame, Ca 94010, (415) 692-1600.

CIRCLE INQUIRY NO. 123

Archer ASCII Keyboard Encoder

The Archer Project-Board kit is an ASCII (American Standard Code for Information Interchange) Keyboard Encoder.

The completed keyboard encoder can be used to provide inputs to all types of equipment designed to operate with ASCII inputs. For example, it can be used with TV typewriters, mini-computers, microprocessors, electric typewriters, or any other devices which require positive or negative ASCII encoded alphanumerical characters.

Features of the Archer ASCII Keyboard Encoder include: a repeat key to control all characters and symbols, a negative-going or positive-going data valid strobe, latch outputs (stores last key code), shift and shift lock capability, true or false ASCII outputs and six extra control keys.

The encoder is able to handle an output of 833 characters per minute (CPM) and has a repeat key rate of 208 CPM. An external power source of 5 VDC at about 500 mA is required to power the encoder.

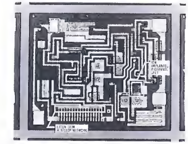
The Archer ASCII Keyboard Encoder Project-Board with complete assembly and parts manual is priced at $14.95. All parts needed to assemble the encoder, including the circuit board, manual and keyboard, but excluding hardware and case, are available from Radio Shack for $57.80.

For further information, contact: 2617 West Seventh Street, Fort Worth, Texas 76107, Phone (817) 390-3272.

CIRCLE INQUIRY NO. 124

Precision Voltage Reference for Instrumentation

A stable 2.5 Volt reference source, type number MC1403/1503 has been designed for critical instrumentation and D-A converter applications, the low-cost monolithic circuit features a maximum output voltage variation of only 1% (±25mV) and a typical temperature coefficient of (ΔVo/ΔT) of 10 ppm/°C.



Laser trimming of resistive networks as a routine process during normal manufacture provides a high yield to a very tight tolerance specification. The laser trimming process adds to the probing time and requires a small amount of additional real estate (compared with non trimmed chips) but effectively increases the tight-tolerance yield to the point that the small cost increase is swamped by the overall cost reductions made possible, compared with device selection to a given spec.

This chip also represents the first utilization of a P-channel J-FET in a linear integrated circuit at Motorola (a relatively new production technology). Ion implantation is the technology responsible for this capability.

Other important circuit specifications include:

Line Regulation = 3mV (max) at input voltage from 4.5 to 15V. 4.5mV (max) at input voltage from 15 to 40 V.

Load Regulation = 10mV (max at output currents from 1 to 11mA.

The devices are immediately available from the Motorola OEM warehouse and from distributor stock.

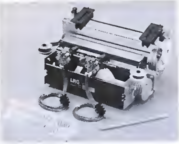
For further information, contact Motorola Semiconductor Products, Inc., P.O. Box 20912, Phoenix, Arizona 85036, Phone 244-6900.

CIRCLE INQUIRY NO. 125

80 Columns Matrix Printer

C. Itoh Electronics, Inc., 5301 Beethoven Street, Los Angeles, California 90066, announces a new 80-column, alphanumeric, dot-matrix printer, Model 7080.

The printer is designed for use in microcomputer terminals, data processing systems, communications, and other areas of application, and less complex, compact, and permits the use of a simple electronic interface.



The price for the quantity of 500 units is \$250.00 each. Production quantities are available from August 1977.

For further information, please contact Mr. Ken Hidaka, C. Itoh Electronics, Inc., Los Angeles. Telephone: (213) 390-7778.

CIRCLE INQUIRY NO. 126

100% Solid-State Voice Identifier

The ID-200 Automatic Voice Station Identifier uses an all solid-state memory system rather than a mechanical tape transport and achieves an exceptionally high level of reliability. The ID-200 connects to radio transmitters and automatically sends the assigned call letters at the prescribed interval in accordance with F.C.C. regulations.

The ID-200 is actually a complete recorder and play back unit. Identification messages may be recorded and re-recorded at any time with "tape-like" voice quality using an operator headset.

Designed to interface with virtually any base station configuration, the ID-200 includes a programmable timer as well as a busy channel lockout system. The unit may be set to identify after every transmission, every time period which included transmitter activity or every time period, regardless of activity. Transmitter activity is sensed by a contact closure. Co-channel activity is sensed by either a contact closure or an audio signal.

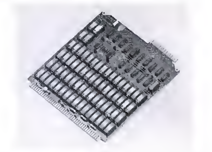
The unit includes a 117VAC power supply and comes equipped for rack mounting.

For further information, please contact Comex Systems, Inc., Executive Drive, Hudson, NH 03051. Telephone: 603-889-8564.

CIRCLE INQUIRY NO. 127

Add-In Memory Products for HP's 21MX Computers

The NS-21 memory boards have a capacity of 16,000 words of 17 bits each, and are completely compatible with the HP system models 2105, 2108, 2112 and 2113. They are used with a control card manufactured by National, or with the HP21 MX series control card.



One control card can communicate with up to twelve 16K NS21 storage cards, for a total storage capability of 192K words. The 16K version of the NS21 replaces two single density 8K cards, saving space and offering increased reliability.

The NS-21 features a savings of about 30 percent over the HP card.

The success of the NS-21, which uses 4K dynamic RAMs, has led to plans for other similar add-ins. This is only the first of a long line of add-in memories National will produce.

The NS-21 is also available in a depopulated 8K version. A single 8K card may be used with a 16K card system, or a maximum of sixteen 8K cards may be controlled together by one card, yielding up to 128K words of memory.

The 16K x 17 bit version of the NS21 memory storage card sells for \$995. Both versions are available for immediate delivery. For further information, contact National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, Calif. 95051, and from National's franchised distributors.

CIRCLE INQUIRY NO. 128

12-Digit VLED Display Board

A multi-digit visual light-emitting diode (VLED) display stick with 12 digits is said to be the largest number available on a single board in the industry today.

The TIL804 characters are seven segment red VLEDs, .27 inch high and feature typical brightness of 500 μcd at 20mA.

Features of the display stick include right hand decimals at each digit, continuous uniform brightness of segments within each digit and a wide viewing angle for distances up to 15 ft.

It is available now is common cathode configuration for ease in multiplex operation on rugged, one-piece printed circuit board construction.

Applications include Citizens Band radios, scanners, digital instrumentation, electronic games, medical electronics, test and measurement equipment and desk top calculators.

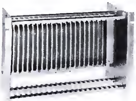
Prices are \$14.65 each in quantities up to 100 and \$11.65 each in quantities above 100 to 999.

For further information, contact Texas Instruments Incorporated, Inquiry Answering Service, P.O. Box 5012, M/S 308 (Attn: TIL804), Dallas, Texas 75222.

CIRCLE INQUIRY NO. 129

ECT-100 Microcomputers

ECT-100 Microcomputers are engineered for use in dedicated control applications, turnkey systems or other Microcomputer systems applications.



The ECT-100 Card Cages are of rugged construction and fit the industry standard 19 inch cabinetry occupying seven RETMA increments (12.25 inches). They hold 20 printed circuit boards 10 x 5.3 on ¾ inch centers which are removable from the front for easy accessibility. The bus structure is the standard 100 pin bus of the personal computers ("Altair" bus or S-100 bus). A wide variety of cards are available from more than 30 manufacturers: ECT-100 Card Cage; ECT-100-8080, A 8080 based Microcomputer; ECT-100-Z80, A Z80 based Microcomputer.

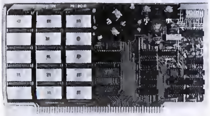
Prices start at $100.

For further information contact Electronic Control Technology, P.O. Box 6 Union, New Jersey 07083.

CIRCLE INQUIRY NO. 130

8K Memory System

MOUNTAIN HARDWARE'S new PROROM board is a S-100 compatible EPROM board with on-board programmer. The board has provisions for 7.5 Kilobytes of PROM and 512 bytes of RAM. The PROM used is the ultraviolet eraseable AMI-S-6834, which is a low cost 512 byte EPROM.



The on-board PROM programmer does not require any special software and can program from one byte, to all 7.5 Kbyte at a time. The on-board RAM provides memory for the often needed stack or other scratch pad area. The board is address selectable with dip switches, and a write protect switch saves programs from accidently being changed. The unit comes with 256 words of RAM and one PROM, which is preprogrammed with a powerful 8080 system monitor. All components and sockets are included, along with a complete documentation package for $164.00. For further information, contact Mountain Hardware, Box 1133, Ben Lomond, CA 95005; (408) 336-2495.

CIRCLE INQUIRY NO. 131

Improved Hybrid Power Rectifier and Voltage Regulator

The Sanken Hybrid Power Rectifier and Voltage Regulator combination has 5 volt 2 amp. output and is designated SI-3050G. The module incorporates Bridge Circuit inside, Power Transistor and Flip Chip structure devices requiring few external components and no adjustments. SI-3050G also features overload and short circuit protection.

Over all the SI-3050G provides excellent production cost economy and assembly simplicity. Priced at 1 up $8.50, 25 up $7.00, 50 up $6.50 and 100 up $6.10. Available from stock. For further information contact: Energy Electronic Products Corp., 6060 Manchester Avenue, Los Angeles, California 90045, (213) 670-7880, TWX 910 328 6161 or 696397 (Telex)

CIRCLE INQUIRY NO. 132

CIRCLE INQUIRY NO. 79

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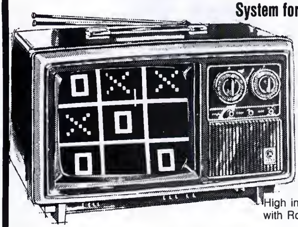

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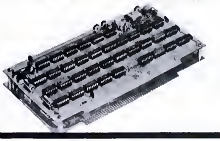

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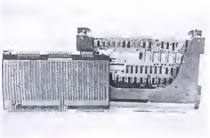
CIRCLE INQUIRY NO. 70

Garry SBC 80/10 Universal Microprocessor Wire-Wrap Interface Board

SBC 80/10 Univesal Microprocessor Interface Board, part number EP 272-38-15 is designed to plug directly into the Intel SBC 604 modular Cardcage/Backplane bus system with power interface connections for ±5 and ±12 VDC.



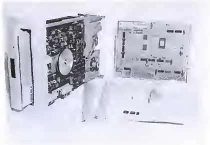
The Gary SBC 80/10 Universal Wire-Wrap board provides 38 columns of 44 low-profile socket terminals per column, with alternate rows of committed ground and voltage wire-wrap terminations. The P/N EP 272-38-15 interface board will accommodate up to 95 16-position I.C. chips or an equivalent mix of 14, 16, 18, 22, 24, 28 or 40-position I.C. chips.

For further information, contact: Garry Manufacturing Co., 1010 Jersey Avenue, New Brunswick, N.J. 08902; Telephone (201) 545-2424.

CIRCLE INQUIRY NO. 136

OSI 470B Floppy Disc

The 470B is an upgrade of OSI's popular 470 floppy disc. The new disc features a GSI model 110 disc drive for 240K bytes single density storage or 480K bytes double density storage. The new disc also features a head load indicator and a prefabricated fifty line interconnecting cable. The introductory special for the 470B is $599 for a fully assembled drive and cable harness, 6502 disc operating system, and controller board in kit form.



The drive is also available fully assembled for OSI Challengers including matching case and power supplies for $990. OSI's floppy disc bootstrap prom allows the owner of any OSI system to use his floppy disc immediately on power up and is available for $29 with either version of the 470B.

For further information, contact OSI, Ohio Scientific Instruments, 11679 Hayden Street, Heron, OH 44234.

CIRCLE INQUIRY NO. 137

OSI 6502 8K BASIC

OSI's new 8K BASIC for the 6052 was written by Microsoft, the people who wrote ALTAIR® 8K BASIC for the 8080. OSI's 6502 8K BASIC is identical to this powerful and popular 8K BASIC with two very important exceptions: our OSI 6502 8K BASIC has automatic string space handling, and it runs faster. Up to 8 times faster than the 8080 BASIC. And hundreds of times faster than many 6800 BASICs.

In fact, the OSI Challenger with OSI 6502 8K BASIC can actually outperform most small and medium-scale minicomputers, as well as every micro there is! And that includes the Z-80.

Perhaps even more amazing than its superlative performance is its surprisingly low price: either $50 or free.

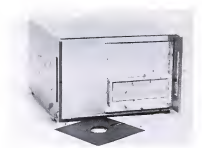
OSI 6502 8K BASIC is available to OSI System kit builders for $50, on your choice of paper tape, audio cassette or floppy disc.

And OSI 6502 8K BASIC comes free with the purchase of any 12K or larger OSI Challenger.

For further information, contact OSI, Ohio Instruments, 11679 Hayden Street, Hiram, OH 44234. CIRCLE INQUIRY NO. 138

Microprocessor Floppy Disc System

A complete floppy disc system for the 6800 microprocessor, housed in a ruggedized, medium blue aluminum cabinet, the Micro-68 floppy disc system comes complete with single or dual disc drive, drive electronics, controller and exorcisor compatible interface for the 6800.



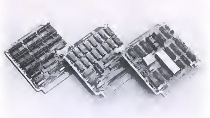
Each IBM compatible disc will hold 1/4 million words of information. Price complete with power supplies is $2595 for the single drive system and $3295 for the dual drive system. Floppy disc operating system, assembler and editor are included. Delivery is 2 weeks.

For further information, contact EPA Electronic Product Associates, Inc., 1157 Vega St., San Diego, CA 92110; (714) 276-8911.

CIRCLE INQUIRY NO. 139

CIRCLE INQUIRY NO. 64

Low-Cost SC/MP Microprocessor Board Family Gives Multiprocessing Capability



A new family of compatible microprocessor cpu and memory application cards, from the Microcomputer Systems Group of National Semiconductor Corporation, combines the features of on-card memory, small size, and low price with the capability of page addressing, multiprocessing and direct memory addressing (DMA) to give an off-the-shelf microcomputer for physically confined situations. Based on the 8-bit, single-chip SC/MP microprocessor, the cards reduce development time in applications ranging from games to industrial controls.

The basic cpu card is the ISP-8C/100 application module with SC/MP microprocessor, timing & control circuits, 256 by 8-bits of random access memory (RAM), a socket for either 512 bytes of programmable-read-only memory (PROM), or 512 bytes of pin-compatible read-only memory (ROM), and complete buffer circuits. Measuring only 4.375 inches by 4.862 inches, the card has an 8-bit Tri-State® data/control bus and a latched 16-bit address bus. The expanded address bussing permits selecting up to 16 memory pages as well as specific locations within the page. Built-in data-bus and address allocation logic facilitates multiprocessor and DMA applications.

The ISP8C/100 card has two separate ports which allow input and output of RS-232-type serial data. Three program-controlled flag output signals and two program-controlled sense inputs allow convenient single-line peripheral control.

The SC/MP has a 46-word instruction repertoire, including both single-byte and double-byte commands. For memory-efficient programming, the processor has five memory and peripheral addressing modes. Four 16-bit address-pointer registers reduce address formation overhead and allow subroutine nesting. The chip design permits static operation with no refresh required.

The ISP-8C/100 SC/MP cpu card is priced at $250 each in quantities to 24; $238 each in quantities above 25. The ISP-8C/002 RAM card is priced at $160 each in 1-24 quantities; $152 each above 25. The ISP-8C/004P card, with 4K of memory supplied, is $525 each in 1-24 quantities; $499 each above 25. The ISP-8C/004B ROM/PROM socket card is $125 each in 1-24 quantities; $119 each above 25. Delivery is stock to 15 days.

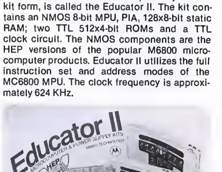
For further information, contact National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, CA 95051.

CIRCLE INQUIRY NO. 140

CIRCLE INQUIRY NO. 97

NMOS Microcomputer Kit—An Educator II

Motorola's HEP/MRO Operations group, introduced an 8-bit microcomputer system in kit form, is called the Educator II. The kit contains an NMOS 8-bit MPU, PIA, 128x8-bit static RAM; two TTL 512x4-bit ROMs and a TTL clock circuit. The NMOS components are the HEP versions of the popular M6800 microcomputer products. Educator II utilizes the full instruction set and address modes of the MC6800 MPU. The clock frequency is approximately 624 KHz.



An executive program, residing in the ROMs, contains routines for examining and modifying memory locations and MPU registers, servicing interrupts, transferring programs to and from cassette tapes, searching tapes for specific programs and a routine to test the finished kit. The executive uses 14 bytes of RAM for a scratchpad; the remaining 114 bytes are for user programs. An optional 128x8-bit RAM can be added to the p.c. board for larger user programs.

Educator II is housed in a sturdy aluminum case. Front panel toggle switches and L.E.D.s are used to enter and display machine code. Edge connectors on the p.c. board provide an interface to the PIA and address, data and control busses for system expansion. Educator II accessories planned for the near future include a keyboard kit, video display kit, a module card rack and power supply, memory modules and applications programs on cassettes.

The p.c. board layout is quite simple; kit construction could be accomplished in one evening. All components necessary to get the microcomputer "up and running" are supplied, even the solder. A separate power supply, of course, is required. A Test-As-You-Build feature provides for accurate, minimum error construction.

A comprehensive construction/instruction manual is included with the kit. Nothing is left to chance in the manual, construction steps are explicitly detailed. Theory of operation of the kit's NMOS microcomputer components are described in an articulate manner. The user is "stepped through" increasingly complex demonstration programs, shown the basics of debugging and how to use the cassette operation. Applications programs are described and listed, along with a listing of the resident firmware.

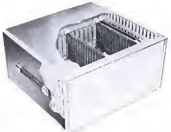
Educator II retails for $169.95 and is available from selected Motorola HEP and MRO distributors and other distributors, nationally. The additional 128x8-bit RAM is also available at the same locations; the retail price is $19.04.

For further information contact: Motorola HEP/MRO National Sales Manager, 705 West 22nd Stret, Tempe, Arizona 85282; (602) 244-3208, or the Technical Information Center, Motorola Semiconductor Products, Inc., P.O. Box 20924, Phoenix, Arizona 85036.

CIRCLE INQUIRY NO. 141

Colorful Enclosures Permit Convenient Card, Module and Component Mounting

A line of enclosures, called VECTOR-PAK, features panels with clear- or black-anodized aluminum finish or with mar-resistant textured vinyl covers in ten standard colors: walnut-grain wood, dark blue, sky blue, orange, avocado, grey, beige, white and black. The bezel and trim extrusions have clear-anodized or black-anodized finish.



The units find applications in laboratory equipment, instruments, computers, peripheral controllers, and development systems. A variety of optional card guides, brackets and straps permit convenient installation of cards, modules, electronic components or electromechanical assemblies from the front, top or rear with either horizontal or vertical orientation.

The internal structure consists of 0.080 inch thick aluminum sidewalls joined by four multipurpose struts. Available in 17 sizes, the sidewalls have repeating patterns of 1.2 inch by 0.15 inch vertically-slotted holes on 0.75 inch centers. The struts are attached directly or with horizontally-slotted brackets to allow precise adjustment of case dimensions. Outside dimensions range from 3.76 inches to 10.75 inches in height, 10.4 inches to 21.6 inches in depth and 8.85 inches to 17.5 inches in width.

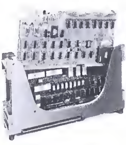
The enclosures may be purchased with or without the interior structure either fully assembled or in easily assembled kits. Without internal mounting structures single-unit VECTOR-PAK enclosure prices range from $65.00 to $95.00; with internal structure the prices range from $125.00 to $185.00. Custom unit prices on request. Delivery is stock to four weeks ARO.

For further information, contact Vector Electronic Company, 12460 Gladstone Avenue, Sylmar, CA 91342; (213) 365-9661; TWX (910) 496-1539.

CIRCLE INQUIRY NO. 142

Analog I/O System for Intel SBC80

Burr-Brown's new MP8600 Analog I/O System is the first 8-bit plug-compatible system offered for Intel's SBC80, and the best priced analog I/O available for that microcomputer. It is the first system of its kind available at a price substantially below that of the computer with which it operates.



A single board contains the analog input and output, and is electrically and mechanically plug-compatible with both the SBC80 and the Intellec® MDS.

Each board can accommodate up to 64 single-ended or 32 differential input channels and two output channels. A high-gain instrumentation amplifier handles input levels as low as 10mV FS allowing direct connection to low-level inputs such as thermocouples.

To simplify software implementation, the MP8600 interfaces to the SBC80 as memory. Each analog input or output channel occupies one memory location. Any memory instruction can be used to access data. Thus, one LDA instruction will input data from one channel to the accumulator. Two adjacent input channels can even be acquired with one LHLD instruction.

The analog input portion of the MP8600 includes an analog multiplexer, high-gain instrumentation amplifier, 8-bit A/D converter, plus necessary timing, decoding and control logic. The analog output portion consists of two 8-bit D/A converters with input latches and control logic. A DC/DC converter is available for operation from the computer's +5VDC power supply.

Input and output specifications include: input voltage range of ±10mV to ±5V, input overvoltage protection of ±15V, and input throughput accuracy better than 0.4% FSR on ±5V range. Ouput voltage range is strap selectable with five ranges to ±10V at 5mA. Output throughput accuracy is better than ±0.4%.

A basic input-only board with eight channels differential or 16 channels single-ended is priced at $295 (1-9) and $198 (100's). A fully loaded board with 32 channels differential or 64 channels single-ended plus two output channels and DC/DC converter is priced at $685 (1-9) and $407 (100's). Delivery for small quantities is two weeks.

For more information, contact Burr-Brown, International Airport Industrial Park, Tucscon, Arizona 85734. Phone (602) 294-1431.

CIRCLE INQUIRY NO. 143

CIRCLE INQUIRY NO. 66

Book Review

SOFTWARE DESIGN FOR MICROPROCESSORS

John G. Webster
and William D. Simpson
Texas Instruments Inc., 1976.

About 400 pages $12.95.

Review by
Judy Scolney Robertson & Larry Robertson

Software Design For Microprocessors "was written to assist technical and non-technical people in taking their first steps toward designing with microprocessors and related software. Topics range from the basics of binary numbers to complex examples of microprocessor applications." Although the authors claim the book was written for those with little or no programming experience, the novice reader had best be an electrical engineer with a fair amount of exposure to digital systems.

Software is presented on the machine language level or at best in assembler code. Only cursory mention is made of the possibility of using higher level languages and subroutine libraries. From the programming standpoint, the book views the processor so narrowly that the authors do not even begin to utilize the power of the computer.

Software Design is a text developed for use in conjunction with the Texas Instruments Microprocessor Learning Module. The book by itself, however, is adequate for the electrical engineer who wishes to utilize microprocessors to replace logic gates and for the highly experienced programmer who desires to use microprocessors for "nitty-gritty" applications. The person who is totally unfamiliar with electronics will flounder a while and rapidly drown in the mire of logic gate and driver descriptions.

The authors have paid extreme attention to detail in their descriptions. Most of these descriptions pertain specifically to the Texas Instruments product line. Examples all refer to special purpose applications of TI equipment, for example an electronic taxi meter and a badge reading system.

About half the book is appendices, including an excellent glossary. One hundred and twenty-nine pages (a full one third of this book) comprise a detailed collection of data sheet descriptions of TI microprocessors. Of the many conversion tables (mostly of the standard variety), by far the most amusing is the list of Common Mathematical Constants which provides values to fifteen places decimal (eight places hexidecimal) of such constants as e (2.B7E15163) and π (3.243F6A89), as well as reciprocals and square roots of these and other commonly used items.

Software Design For Microprocessors is by no means a basic text, but the electrical engineer or experienced programmer with some knowledge of logic circuits may find it a helpful reference for special purpose microprocessor applications.

Software Design For Microprocessors is available through Texas Instruments, Inc., P.O. Box 3640, M/S-84, Dallas, TX 75285.

THE UNDERGROUND BUYING GUIDE FOR HAMS, CBERS, EXPERIMENTERS AND COMPUTER HOBBYISTS

Dennis A. King
PMS Publishing Company, 1977.
185 pages. Paperback $5.95

Review by
Judy Scolney Robertson & Larry Robertson

The orientation of ***The Underground Buying Guide*** is best expressed in the author's dedication:

> This book is dedicated to:
> Electronic hobbyists world wide who believe that building is better than buying, that experimenting and week-end dabbling is the best instructor that anyone ever had and that the greatest satisfaction that can come from a hobby is building something that works from scratch.

Dennis King has compiled, out of his own experience, a handy listing of electronics parts, services and vendors arranged in three easily referenced lists. Part One of the book is an alphabetical index of firms described in detail with addresses and telephone numbers. There is enough information about each supplier that the hobbyist can order any component he may need based on the data provided in this book. ***The Guide*** lists which firms discount prices, which give free catalogs and other literature, which have toll-free numbers (the numbers are provided) and which accept credit cards, and if so, lists the cards accepted. Some prices and price ranges are also given, as is a sampling of products and services offered by each supplier. In addition to the alphabetical listing, firms are also sorted and listed by state (section two) and references are given to the detailed descriptive data in the alphabetical section.

Parts and services are listed alphabetically in section two of ***The Guide.*** No details are provided for any of the items listed, but a rather complete selection of suppliers is provided along with referrals to page numbers in the alphabetical listing.

The Underground Buying Guide is exactly what the title suggests — a buying guide designed for the electronics hobbyist. The user may find exactly what he needs at a lower price. The listing includes small firms and mail order houses, often with discount prices. We find ***The Guide*** to be extremely useful and applaud King's efforts to compile and share the results of his experiences in acquiring equipment for hams, CBers, experimenters, and last, but by no means least, home computer owners and builders.

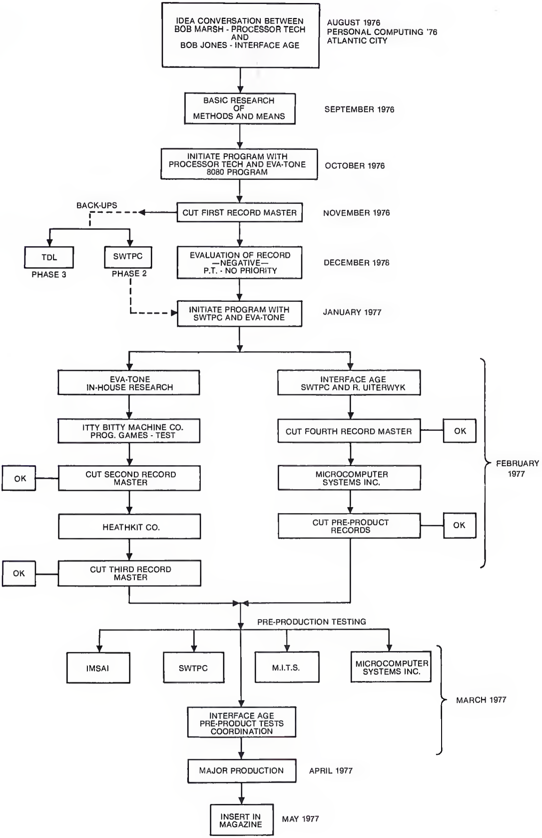
The Guide is so new it has not appeared in any stores yet. It is available by mail from Peninsula Marketing Services, 12625 Lido Way, Saratoga, CA 95979. Add 50 cents for postage and handling. California residents add 39 cents sales tax.

Next month the Robertsons will review *Techniques of Program Structure and Design* by Edward Yourdon, Prentice-Hall 1975.

The Shoestring, Start-at-Home, Computer Business Handbook: 21 Ventures from the Garage, Basement, Bedroom or Closet for the Aspiring Computrepreneur by George Alan, Datasearch, Inc. 1977.

Vectored from page 28

MILESTONE CHART



HARDWARE

by Roger Edelson
Hardware Editor

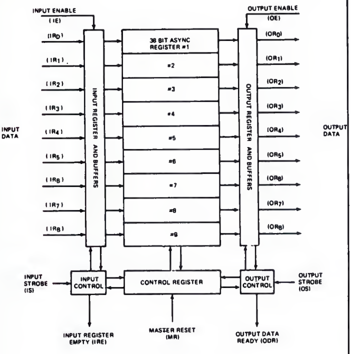


Figure 1. Block Diagram

This month the Hardware Report will cover an IC which is a very useful device for interfacing between your computer and other devices with a high data flow. The chip is Western Digital's MOS/LSI FR1502E First-In/First-Out Buffer Register. This device is more commonly referred to as a FIFO. The advantage of a FIFO is that it can provide SILO/ELASTIC storage to buffer asynchronous data inputs to a synchronous computer interface. The FR1502E FIFO is an asynchronous memory organized in a 9-bit by forty character stack. Characters are loaded onto the top of the stack and then "sink to the bottom of the stack or are halted just above the level of previously entered data. All this takes place without the need for the application of external clocking signals. As a character is removed from the bottom of the stack, all of the previously loaded data will drop one character nearer to the output.

FR1502E FIFO Features include:

1 SILO/ELASTIC STORAGE
2 40 CHARACTERS BY 9 BITS
3 EXPANDABLE CHARACTER AND BIT SIZE WITH NO EXTERNAL COMPONENTS
4 MAXIMUM ASYNCHRONOUS I/O ACCESS (Subgroups available in dc to 550 KHz and DC to 250 KHz)
5 INPUT/OUTPUT READY STATUS FLAGS
6 THREE-STATE I/O WITH SEPARATE ENABLES
7 DIRECTLY TTL AND DTL COMPATIBLE
8 MASTER RESET
9 28-PIN DIP PACKAGE

Applications for this FIFO include data transmission buffers, auto dialers, key-to-tape or key-to-disc equipment, CRT buffer memory, and any place an asynchronous to synchronous (or asynchronous) buffer is required.

The FR 1502E FIFO provides signals for handshaking to insure data exchange without error. Data can be entered whenever the IRE (Input Register Empty) line is high. Data is loaded by strobing the IS (Input Strobe) line high while the IE (INput Enable) line is also high. The positive going edge of the IS resets IRE and the negative going edge enables the data to begin rippling through the FIFO. As soon as this data has left the input register, IRE will again go high and additional data can be loaded. When data reaches the FIFO, the ODR (Output Data Ready) line will go high. A low level pulse on the OS (Output Strobe) line will shift this data out of the FIFO, if the OE (Output Enable) line is also high. The FIFO data outputs are floating whenever the OE line is low. The negative going edge of the OS pulse resets ODR and causes data in the FIFO to ripple towards the output.

The logic conventions of the handshaking signals and the internal delays of the FIFO have been chosen to allow direct expansion of the buffer memory without external hardware.

REPORT

Figure 1 provides a block diagram of the FIFO. It can be seen that the chip is arranged as a series of three registers (a 1-bit input, a 38-bit asynchronous and a 1-bit output register). Control is divided into input, register, and output control. The input control provides the IRE signal and responds to the IS line. The output control provides the ODR signal and responds to the OS line. IE and OE signals enter the Input and Output registers respectively.

Let's take a look at the individual signals themselves:

IR0-IR8 Input Register Data) — These are the nine input data lines. Data on these nine lines are parallel loaded into the FIFO when the IS is high and the IE is also high. Loading will not occur unless the first stage is empty as signaled by a high IRE. These inputs are TTL compatible and are tri-state — that is, when the IE goes low, the internal resistor pull-ups are disconnected resulting in a floating input.

IRE (Input Register Empty) — When the IRE line is high data may be loaded into the first stage. IRE is reset to a low by the positive going edge of the input pulse.

IS (Input Strobe) — Data on the IRD lines is loaded into the first stage of the FIFO when this line is high, if the IE line is also high. On the negative going edge of IS the loaded data begins shifting towards the FIFO output. When the IE line is low the IS line is floating.

MR (Master Reset) — This input when strobed high, clears the FIFO control register, sets IRE high, sets ODR low, and leaves the bit registers including the output register data (ORO-OR8) lines at an unspecified state. This is particularly important to remember — the bit registers are not cleared by the MR line.

ORO-OR8 (Output Register Data) — The output data lines present the previously loaded data in a first-in/first-out manner after it has fallen to the output stage. The data lines are only valid when the OE is high. The outputs are floating when the OE is low.

OS (Output Strobe) — The negative going edge of this signal resets the ODR line and then shifts the data in the FIFO if the OE line is high. The positive going edge of this signal can occur before the data ready condition occurs.

ODR (Output Data Ready) — When valid data is available at the data output lines the ODR signal will go high. The ODR is reset to a low condition by the negative going edge of the OS, if the OE is high.

IE (Input Enable) — This line controls the tri-state condition and the control of the input register and control. The line must be high before the FIFO will respond to IS Pulses. The IRD lines are floating when this line is low.

OE (Output Enable) — This line must be high before the ORD lines will respond to the logical output levels of the previously loaded data. When the OE line is low the ORD lines are floating.

The chip requires +5 volts (±5%) for V_{SS} and −12 volts (±5%) for VGG.

Figures 2 and 3 indicate, respectively, the Input and Output timing characteristics of the chip. Note that in both cases the chip will not respond unless the appropriate ENABLE line is high. When the lines are low the state of the chip cannot be changed but the previously stored data will not be lost.

Let us take a look at the Input timing. When the IRE line is high the FIFO is ready to accept another nine bits of data. At this point the positive going edge of the input strobe resets the IRE line to insure that no more data will attempt to be loaded until the present data has been processed. The IS signal cannot go high until 350 ns. after IE has been brought high. The data must be stable within 150ns after IS has gone high.

In most cases it is easier to set up the data before strobing the IS line. However, if the two events are simultaneous, make sure that there is no more than 150ns delay in the data lines. The IS signal must remain high for at least 175ns. After the IS signal has gone low the data must remain stable for at least an additional 75ns. If the data does not remain valid for this period, unreliable operation will result. I found it very convenient to have the data valid bracket the IS signal.

When the IS signal goes low the data begins to be transferred from the Input Register to the 38-bit asynchronous register. As soon as the Input Register is free to accept more data, the IRE line will go high. This can take a maximum of 825ns. before the Input register will again be empty after the IS signal goes low. The logic design should either insure that no new data is presented prior to 75ns. after IS goes low and sufficient time is allowed to process the data before expecting the chip to accept new data. The alternative technique would be to allow the rising edge of IRE to clock the new data to the FIFO.

The Output timing follows the same general pattern as the Input timing. A high ODR signal indicates that a character is available at the output lines. After the using

SWITCHING CHARACTERISTIC

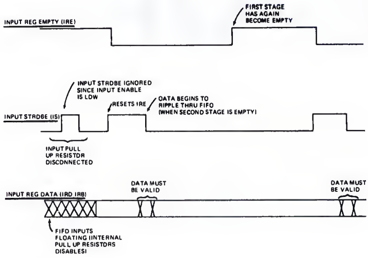


Figure 2. Input Timing

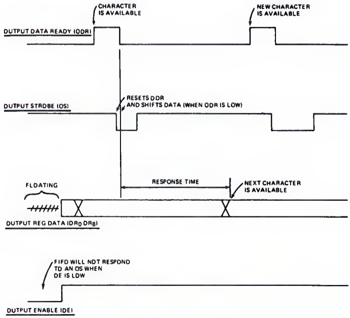


Figure 3. Output Timing

SWITCHING WAVE FORMS

INPUT DETAIL

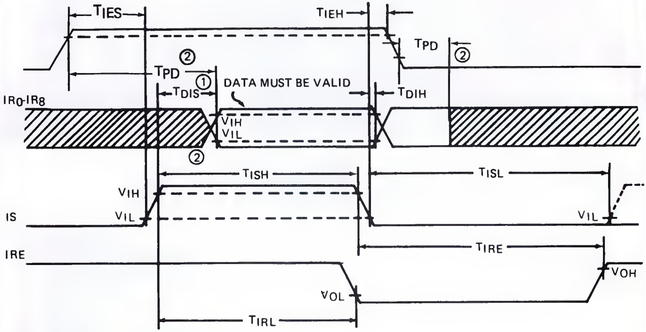
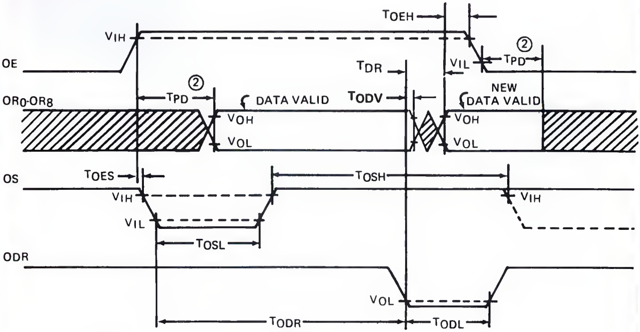


Figure 4.

OUTPUT DETAIL

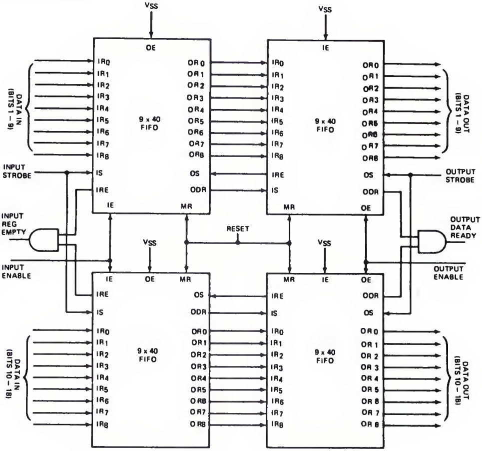


NOTES:

1. DATA, IR_0-IR_8, must be stable in T_{DIS} nsec, or less, after IS is at a high level input voltage, V_{IH}.
2. Three-state inputs/outputs are under control of IE/OE and require a maximum of 500 nsec to settle after an IE/OE transition.

Figure 5.

EXPANSION EXAMPLE



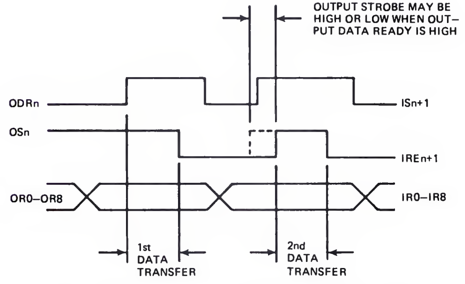


Figure 6. Interchip Timing — Expandable Memory Operation

device has processed the data, the OS line (which has been high) is strobed low. The negative going edge of the OS line will reset the ODR signal to a low state, indicating that a new word is being transferred to the output register. The OS signal may be strobed low concurrently with the rising edge of the OE signal. The FIFO can take up to a maximum of 500ns. before the OER signal is reset by the negative edge of the OS. Data will remain valid for as long as the ODR signal is high. The OS signal must remain in the low state for a minimum of 300ns. The OS signal must remain high for at least 200ns. before it can again be strobed low.

These timing relationships are shown in more detail in Figures 4 and 5. Table 1 lists all the timing characteristics for the FR1502 and the two (2) slower members of the family. In order to meet the maximum data transfer rate of 1 MHz. optimum use must be made of the handshaking signals provided by the chip. When operating at lower data rates the design is more forgiving and the control can be done with less trouble. In one case, using a 200 KHz data transfer rate, it turned out not to be necessary to use the IRE signal at all as the chip was always ready to accept new data before the external logic presented it.

Table II provides a list of the electrical characteristics of the FR1502 series. As can be seen from the logic levels the device is TTL compatible. However, the FIFO can only drive one normal TTL load as I_{OL} is 1.6ma.

The FR1502E requires a source of -12V. for proper operation, and the device is not particularly a power miser. Approximately .33 watts of power is required from the +5V. supply and about .36 watts is required from the -12V. supply. Also please note, the FIFO is only specified from 0-77 degrees C.

Figure 6 illustrates the method used to expand the FIFO size. In the example the memory has only been expanded to 18 bits wide by 80 bits deep, but the method is the same for greater expansions. If the IRE and the ODR signals are being used, gates must be included to insure that IRE does not go high until all the FIFOs are ready to accept data, and similarly the individual ODR signals must be ANDED to insure that a composite ODR signal reflects the status of all the chips.

As can be seen, this chip provides an extremely easy method to interface two devices having different and nonsynchronous data rates, and the input rate is higher than the accepting device can process asychronously.

TABLE 1

SWITCHING CHARACTERISTICS — SEE "SWITCHING WAVEFORMS"
($V_{SS} = V_{CC} = 5V$, $V_{DD} = 0V$, $V_{GG} = -12V$, $T_A = 25°C$, $C_{LOAD} = 10$ PF)

		FR1502E		FR1502E-01		FR1502E-02	
SYM	PARAMETER	MIN	MAX	MIN	MAX	MIN	MAX
T_{IES}	INPUT ENABLE SET TIME	350NS		700NS		1400NS	
T_{DIS}	DATA INPUT SET TIME		150NS		300NS		600NS*
T_{ISH}	INPUT STROBE HIGH TIME	175NS		350NS		700NS	
T_{DIH}	DATA INPUT HOLD TIME	75NS		150NS		300NS	
T_{IRL}	INPUT REGISTER LOAD TIME		325NS		650NS		1300NS
T_{IEH}	INPUT ENABLE HOLD TIME	0NS		0NS		0NS	
T_{IRE}	INPUT REGISTER EMPTY TIME INPUT STROBE		825NS		1650NS		3300NS

Branch to page 92

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T_{PD}	INPUT/OUTPUT PROPAGATION DELAY	500NS	1000NS	1500NS
T_{OSL}	OUTPUT STROBE LOW TIME	300NS	600NS	1200NS
T_{ODR}	OUTPUT DATA RESET TIME	500NS	1000NS	2000NS
T_{ODV}	OUTPUT DATA VALID TIME	75 NS	150NS	300NS
T_{DR}	DATA RESET TIME	400NS	800NS	1600NS
T_{OEH}	OUTPUT ENABLE HOLD TIME	0NS	0NS	0NS
T_{ODL}	OUTPUT DATA READY LOW TIME	500NS	1000NS	2000NS
T_{OSH}	OUTPUT STROBE HIGH TIME	200NS	400NS	800NS
T_R	MAXIMUM RIPPLE TIME	20US	40US	80US
F_D	MAXIMUM DATA RATE	1MHz	500KHz	250KHz

FOR CONDITIONS, SEE FIGURE 1, NOTE 1.

TABLE II

MAXIMUM RATINGS	
V_{GG} Supply Voltage	+0.3V to −20V
V_{DD} Supply Voltage	+0.3V to −20V
Clock Input Voltage*	+0.3V to −20V
Logic Input Voltage*	+0.3V to −20V
Logic Output Voltage*	+0.3V to −20V
Storage Temperature	−55°C to +150°C
Operating Free-Air Temperature T_A Range	0°C to + 70°C
Lead Temperature (Soldering, 10 sec.)	300°C

$*V_{GG} = V_{DD} = 0V$

NOTE: These voltages are measured with respect to V_{SS} (Substrate)

ELECTRICAL CHARACTERISTICS

($V_{SS} = V_{CC} = 5V \pm 5\%$, $V_{DD} = 0V$, $V_{GG} = +12V \pm 5\%$, $T_A = 0°C$ to $+70°C$ unless otherwise specified)

SYMBOL	PARAMETER	MIN.	MAX.	CONDITIONS
	INPUT LOGIC LEVELS[1]			
V_{IL}	Low-level Input Voltage		0.8V	$V_{SS} = 4.75V$
V_{IH}	High-level Input Voltage	$V_{SS} - 1.5V$		
	OUTPUT LOGIC LEVELS[2]			
V_{OL}	Low-level Output Voltage		0.4V	$V_{SS} = 5.25V$, $I_{OL} = -1.6mA$
V_{OH}	High-level Output Voltage	$V_{SS} - 1.0V$		$V_{SS} = 4.75V$, $I_{OH} = 200$ A
	INPUT CURRENT[1]			
I_{IL}	Low-level Input Current (each input)		−1.6mA	$V_{SS} = 5.25V$, $V_{IN} = 0.4V$
	OUTPUT CURRENT			
I_{OS}	Short-circuit Output Current**		−2.2mA	$V_{SS} = 5.25V$, $V_{OUT} = 0V$
I_{SS}	SUBSTRATE SUPPLY CURRENT		65mA	$V_{SS} = 5.25V$, $V_{GG} = 12.6V$
I_{GG}	GATE SUPPLY CURRENT		30mA	$V_{IN} = 0.4V$

**Note more than one output should be shorted at a time.

Note: 1) Inputs under INPUT ENABLE control when disabled (V_{IL} applied to IE), are logically and electrically disconnected and caused to float.

2) Outputs under OUTPUT ENABLE control when disabled (V_{IL} applied to OE), are logically and electrically disconnected and caused to float.

The Three-State Output has three states:
(1) Low impedance to V_{CC}
(2) Low impedance to GND
(3) High impedance OFF ~ 10 Megohm.

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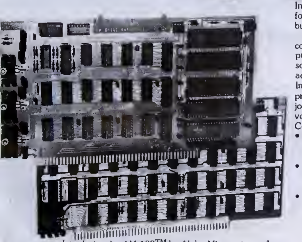

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Roger H. Edelson, Hardware Editor

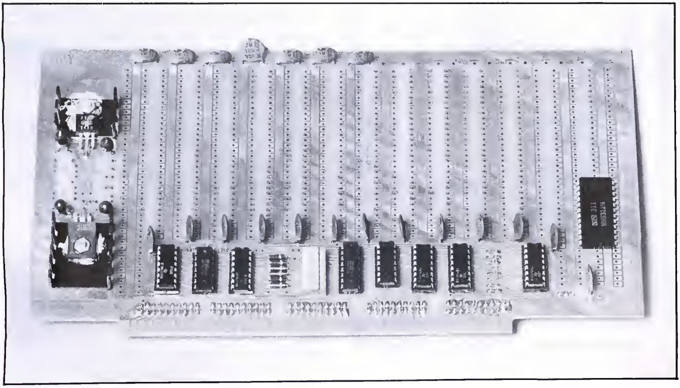
This month I'll be reporting on a board that many of you could live your whole life without ever needing — but some of us are extremely happy that PolyMorphic Systems introduced this card. The Poly I/O Ideaboard is a card designed for the computer enthusiast who wants to "do his own thing". In general, all the circuitry used for any Input/Output application is provided on the board and the designer is free to work on his own application design.

The POLY I/O board is designed as a wirewrap prototyping board that is compatible with S-100 Bus computers both physically and logically. The board is configured such that the I/O decoding can be either as an I/O Port or as a memory mapped I/O.

Let's take a look at the physical layout of the kit before we delve into the logical design. The board is, as previously mentioned physically compatible with the S-100 bus systems. It is a high quality printed circuit board on a glass base. All the etch is tinned and the edge board connectors are gold plated for reliability. No solder masking is used as it would not be appropriate for a user customized device. The component identification is skimpy, but adequate, as the layout diagram is very complete. All the ICs for the I/O function provided by PolyMorphic Systems have sockets. Wire-wrap connectors are provided for wiring to the S-100 Bus pins. A single +5 V. regulator and associated filter capacitors are provided, as well as space and some printed wiring traces for one additional I/C regulator. Space, and some hookup configuration has also been provided for two zener voltage regulators. It is therefore possible to provide up to four different voltage supplies on the card.

Generous prototyping space is provided, enough for up to 59 16-pin IC sockets. The solder pads are laid out so that 24-, 28-, or 40-pin devices may also be mounted. When these wider spaced ICs are used, one line of solder pads is covered by the chip; a small price to pay for the universality of the board.

The construction of the board is extremely easy, taking no more than one-half hour. Care must be taken in soldering the components because of the absence of any solder masking, but no particular problems were encountered. Adequate power and ground bus trace is provided to minimize circuit noise. Solder pads for noise decoupling capacitors are provided at each end of the IC mounting lines, unfortunately PolyMorphics provides only ten - .1 μFd. capacitors, while providing space for 26 capacitors. The problem is to provide sufficient parts for most applications, while keeping the cost reasonable. If the designer needs to completely fill the board with parts, he will have to add some of his own decoupling capacitors. The same dilemma is undoubtedly responsible for the lack of any wire wrap sockets for the



experimenter-designed circuitry. The question would be: how many, of which socket should be provided. PolyMorphic has refrained from trying to cut the Gordian Knot by simply forcing the user to purchase his own sockets.

Again, as I said earlier, the board goes together very easily and no assembly problems were encountered.

Let's now take a look at what PolyMorphic has provided as far as the I/O circuitry. The design includes address decoding which, though not completely general, is probably sufficient for most requirements. Read and write strobes, four separately addressed, and tri-state data buffers are provided. As mentioned earlier, a +5 volt regulator and associated circuitry is also included in the kit. Both individual and ganged wire-wrap pins are also provided.

Figure 1 is the schematic for the Poly provided I/O addressing. The data lines are buffered both for Input and Output by SN74367 Tri-State buffers. Both the input and output buffers are under control of their respective strobes. A0 and A1 are used in conjunction with a 74LS13 dual two-line-to-four line decoder to provide four addressed read/write strobes. The A0 and A1 lines are buffered by a 74LS14 to schmidt trigger to provide noise immunity.

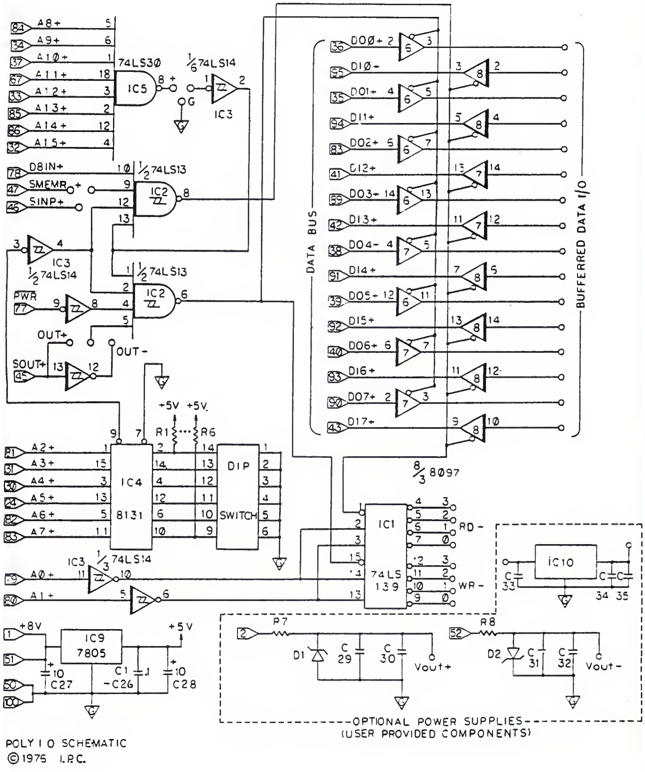
Board addressing may be done with input or output instructions as with any Port, or with memory addressing in the memory mapped mode. The mode selection is done by jumpers. In either the normal (port) mode or the memory-mapped mode the user can set the dip switch to select any address provided by address lines A2 through A7. In the memory-mapped mode the board is placed at location FFxx by the action of the eight-input NAND gate IC5. In the memory-mapped mode all the inputs to this gate (A8 through A15) must be high to allow generation of the read/write strobes. In the normal mode this gate is jumpered out of the circuit. If the memory mapped-mode is selected then SMEMR must be jumpered to pin 9 of IC2. If instead, the normal (PORT) mode is desired, SINP must be connected to this pin. A selection of the appropriate connection of SOUT must also be made. If the user desires to use the memory-mapped mode, the SOUT- must be connected to Pin 5 of IC 2. In the normal mode this pin is connected to SOUT+. The outputs of IC 2 besides being used to control the state condition of the Tri-State Data buffers, also controls the ENABLE line on the 74LS139 to insure that no strobes are generated unless the correct addressing conditions are met.

When a low is present at either of the ENABLE inputs to the LS139 the low order address bits are decoded. Depending on the condition of A0 and A1 one out of the four possible strobes is generated. Table I indicates the addressing of the strobes.

Table I.

Read Strobe Enabled	Enable (pin 1)	A0	A1	Write Strobe Enabled	Enable (pin 1)	A0	A1
none	HI	X	X	none	HI	X	X
RD0	LO	LO	LO	WR0	LO	LO	LO
RD1	LO	LO	HI	WR1	LO	LO	HI
RD2	LO	HI	LO	WR2	LO	HI	LO
RD3	LO	HI	HI	WR3	LO	HI	HI

It is unfortunate that PolyMorphic did not choose to allow full decoding of the eight high order address bits. For example, in my system the monitor resides in memory above location F0. This makes it impossible for me to use the memory-mapped mode with the Poly Idea-



A8+
A9+
A10+
A11+
A12+
A13+
A14+
A15+
74LS30
IC5
1/6 74LS14
IC3
D8IN+
SMEMR
SINP+
1/2 74LS13
IC2
1/2 74LS14
PWR
OUT+
OUT-
SOUT+
DATA BUS
BUFFERRED DATA I/O
D00+
D10-
D01+
D11+
D02+
D12+
D03+
D13+
D04+
D14+
D05+
D15+
D06+
D16+
D07+
D17+
8/3 8097
+5V
R1
R6
A2+
A3+
A4+
A5+
A6+
A7+
IC4
8131
DIP SWITCH
IC1
74LS 139
RD-
WR-
IC10
A0+
A1+
1/3 74LS14
+8V
IC9
7805
+5V
C27
C26
C28
C1
R7
R8
D1
D2
C 29
C 30
C 31
C 32
C 33
34 35
Vout+
Vout-
OPTIONAL POWER SUPPLIES
(USER PROVIDED COMPONENTS)
POLY I O SCHEMATIC
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Figure 1.

board. An 8130 and a buffer for the address lines could have been used. Combined with a ten-pole dip switch this would have provided completely flexible addressing. However, even without this capability the Ideaboard is still extremely versatile.

The use of an 8131 for address decoding is a very nice idea as the bus inputs are high impedance inputs so as to not load the S-100 bus.

As we have seen, with the exception of the lack of a fully general addressing scheme, the Poly I/O Ideaboard is a very handy device to have around the shop if you like to "brew your own". I have used mine for audio outputs and to design some specialized cards for a dedicated microprocessor application. The use of wire-wrapping makes the card extremely versatile and re-usable.

One of the very nice features of the IdeaBoard is the very extensive checkout and test section of the applications manual. Test programs are provided for both the normal mode and the memory mapped mode. Both programs are reproduced here with the kind permission of PolyMorphic Systems. Besides the programs PolyMorphic also gives troubleshooting instructions to fault isolate to the defective chip. All of this makes the board very easy to get running.

Additionally there is a section in the manual on installation of customer-provided voltage regulators. The circuit board is set up to accept either 78XX or 79XX series regulators of their equivalent 340 or 320 series devices. The board layout for this regulator and a pair of Zener regulators are shown in Figure 2. In the case shown the Zeners provide both positive and negative voltages from the S-100 Bus unregulated supplies.

The zener regulators typically consist of an input register, a 10μ f tantalum capacitor, a $0.1\ \mu$ f ceramic capacitor, and a zener diode. The input resistor value can be calculated as follows: Measure the input voltage to be used (approximately $+20$ or -20 volts) with the D. C. scale on a voltmeter. Subtract the desired output voltage. Subtract 25% of the remainder. Divide by the maximum current to be used by your circuitry.

$$\frac{V_{IN} - V_{OUT}}{I_{OUT}\,(max)} \times 0.75$$

ADDRESS

```
ADDRESS   HEX CODE    INSTRUCTION              COMMENTS

ØCØØ      21 Ø8 ØC    BEG    LXI H,MODIF+1  ;  HL = address of
                                                  port tested
ØCØ3      36 CØ       FPORT  MVI M,CØH      ;  set first port =
                                               CØ
ØCØ5      Ø6 CØ              MVI B,CØH
ØCØ7      D3 CØ       MODIF  OUT CØH        ;  output to selected
                                               port
ØCØ9      ØE FF              MVI C,ØFFH     ;  select time be-
                                               tween outputs
ØCØB      Ø4                 INR B          ;  next port
ØCØC      7Ø                 MOV M,B
ØCØD      CD 1F ØC    OMT    CALL TIME      ;  wait ½ second
ØC1Ø      ØC                 INR C
ØC11      C2 ØD ØC           JNZ OMT        ;  wait longer if
                                               reg C     FF
ØC14      78                 MOV A, B
ØC15      E6 Ø7              ANI 7
ØC17      FE Ø4              CPI 4          ;  last port?
ØC19      CA Ø3 ØC           JZ FPORT       ;  yes
ØC1C      C3 Ø7 ØC           JMP MODIF      ;  no
ØC1F      11 ØØ ØØ    TIME   LXI D,Ø        ;  timing loop
ØC22      1C          LOOP   INR E
```

```
ØC23    C2 22 ØC        JNZ LDDP
ØC26    14              INR D
ØC27    C2 22 ØC        JNZ LDDP
ØC2A    C9              RET          ; end of timing loop
```

Normal Mode Test—Start Address = 0C00 H1

If it is necessary to check an individual strobe line, adjust the program as follows:

Address Insertion

Address	Insertion
0C04	Port # - C0, C1, C2 or C3
0C06	Port # - same as 0C04
0C07	D3 for write strobe, DB for read strobe
0C0A	Two's complement of the number of times (½ second each) the timing loop is repeated - thus if you are checking one strobe, FC will give you four repetitions of the timing loop for a total of two second.
018	Hex equivalent of the two least significant binary digits of the port number 1, i.e. 01 for port C0, 02, for port C1, etc.

If you must relocate the program—i.e. your computer cannot use the program at the memory locations given—change the address codes in the program. That is, change the last two bytes of each three byte instruction except LXI D, 0. As an example, if you wish to re-locate the program to 4000 hex, change Memory-Mapped Mode.

Test—starting address = 0C00 hex

MEMORY MAP MODE

```
ADDRESS  HEX CODE    INSTRUCTION            COMMENTS

ØCØØ    21 Ø8 ØC    BEG   LXI H,MDDIF+1   ; HL = address of
                                             ported tested
ØCØ3    36 CØ       FADR  MVI M, CØ       ; set first port
                                             address = FFCØ
ØCØ5    Ø6 CØ             MVI B,CØ
ØCØ7    32 CØ FF    MØDIF STA ØFFCØH      ; output to port
                                             address
ØCØA    ØE FF             MVI C,ØFFH      ; select time
                                             between outputs
ØCØC    Ø4                INR B           ; next port address
ØCØD    7Ø                MDV M,B
ØCØE    CD 2Ø ØC    ØMT   CALL TIME       ; wait ½ second
ØC11    ØC                INR C
0C12    C2 ØE ØC          JNZ ØMT         ; wait longer if
                                             reg C   FF
ØC15    78                MDV A,B
ØC16    E6 Ø7             ANI 7
ØC18    FE Ø4             CPI 4           ; last port address
                                             used?
ØC1A    CA Ø3 ØC          JZ FADR         ; yes
ØC1D    C3 Ø7 ØC          JMP MDDIF       ; no
ØC2Ø    11 ØØ ØØ    TIME  LXI D,Ø         ; timing loop
ØC23    1C          LODP  INR E
ØC24    C2 23 ØC          JNZ LDDP
ØC27    14                INR D
ØC28    C2 23 ØC          JNZ LDDP
ØC2B    C9                RET             ; end of timing
                                             loop
```

If it is necessary to check an individual strobe line, adjust the program as follows:

Address	Insertion
0C04	Port address - FFC0, FFC1, FFC2, or FFC3
0C06	Port # - same as 0C04
0C07	2A for write strobe, 3A for read strobe
0C0B	Two's complement of the number of times (½ second each) the timing loop is repeated - thus if you are checking one strobe, FC will give you four repititions of the timi,,g loop for a total of two seconds.
0C19	Hex equivalent of the two least significant binary digits of the port address plus 1, i.e. 01 for FFC0, 02 for FFC1, etc.

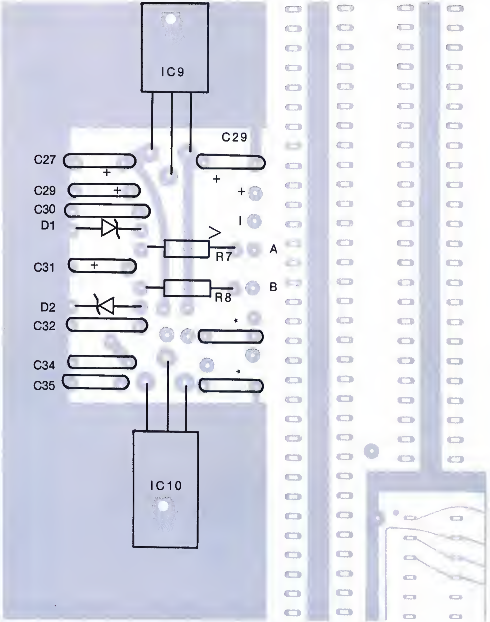

Figure 2. Voltage Regulator Circuits
***One of these is C33; this depends on the manufacturers specifications for the regulator used. The other is a jumper to provide ground to the regulator. All three leads must be jumpered.**
A. Is +18 to 24 volts unregulated.
B. Is ¢18 to 24 volts unregulated.

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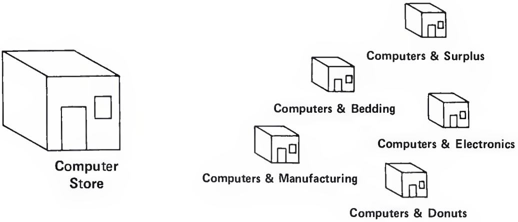

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By Robert A. Stevens
Software Editor

Software Section

SUMMARY OF PROGRAMS FOR

This month's issue of INTERFACE AGE includes eight software articles, featuring three software development programs, one I/O interface driver program, two application programs, and two game programs. These programs include the following:

- A Motorola 6800 Hex Format To Intel Format converter program by Floyd Nordin provides capability of programming EPROM's in 6800 object code using an 8080 microcomputer software development system.
- A User TTY Handler For The Z-80 Development System written by Richard E. Maly provides three subroutines (SETUP, TRYOUT & TTYIN) and an INTERRUPT HANDLER for the Z-80 Microcomputer System.
- A Number Base Conversion Routine written in BASIC by John W. Swain provides program capability of converting numbers from any of the standard bases to another number basis and vice versa.
- A SEIKO Printer Hardware Interface & Software Driver by Philip Roybal provides hard copy output for the SC/MP microcomputer.
- A Checkbook Balance Program by Jim Huffman provides another practical application program for your microcomputer and at the same time helps justify to your wife the $2,000 spent on your system instead of going skiing on your vacation last year.
- A Logic Circuit Analysis Program for the 6502 by Robert Bishop provides binary state Truth Tables outputs of logic networks.
- An Apple STAR-TREK game program written by Robert J. Bishop provides a version of the well known STAR-TREK program in BASIC for the 6502 microcomputer system.
- John Conway's Game of Life program by Alan R. Miller not only provides another version of the Game of Life but also provides details on the type of life patterns encountered in the game.

```
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PTSC  PAPER TAPE SOURCE CODE                      FROM RESIDENCE OF CALIF.
PTOC  PAPER TAPE OBJECT CODE                   :  USA POSTAGE + HANDLING OR
PTBC  PAPER TAPE BASIC CODE                       THIRD CLASS USA POSTAGE +
PTAL  PAPER TAPE ASSEMBLY LISTING                 HANDLING OR SURFACE RATE
PTSL  PAPER TAPE SOURCE LISTING                   FOREIGN POSTAGE  @
PTOL  PAPER TAPE OBJECT LISTING                   THREE TIMES THIRD CLASS
PTOD  PAPER TAPE OBJECT DUMP                      USA POSTAGE RATE(STANDARD
PTBL  PAPER TAPE BASIC LISTING                    OR SURFACE RATE FOREIGN
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CTSL  CASSETTE TAPE SOURCE LISTING                POSTAGE RATE (ALTERNATE)
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CTOD  CASSETTE TAPE OBJECT DUMP                %  VENDOR SOFTWARE PACKAGE -
CTBC  CASSETTE TAPE BASIC CODE
CTBL  CASSETTE TAPE BASIC LISTING
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HCSC  XEROX HARD COPY OF SOURCE CODE
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HCBC  XEROX HARD COPY OF BASIC CODE
HCAL  XEROX HARD COPY OF ASSEMBLY LISTING
HCALF FULL SIZE XEROX HARD COPY OF ASSEMBLY LISTING
HCSL  XEROX HARD COPY OF SOURCE LISTING
HCOL  XEROX HARD COPY OF OBJECT LISTING
HCOD  XEROX HARD COPY OF OBJECT DUMP
HCBL  XEROX HARD COPY OF BASIC LISTING
TEXT  XEROX HARD COPY OF PRINTED TEXT
PTTL  PAPER TAPE TEXT LISTING
CTTL  CASSETTE TAPE TEXT LISTING
MAN   MANUAL
HCGR  XEROX HARD COPY OF GRAMMAR
PTGR  PAPER TAPE COPY OF GRAMMAR
BBSL  XEROX HARD COPY OF BINARY BOOTSTRAP LOADER
HBSL  XEROX HARD COPY OF HEX BOOTSTRAP LOADER
PACK  PACKAGE PRICE INCLUDES ALL ITEMS/PROGRAM # WITH SYMBOL <

      SUFFIX C= HAND ASSEMBLED CODE
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DEFINITIONS:

  ASSEMBLY LISTING: COMPUTER ASSEMBLED SOFTWARE PROGRAM LISTING
                    THAT INCLUDES SYMBOLIC ASSEMBLY LANGUAGE SOURCE
                    CODED INSTRUCTIONS WITH COMMENTS PLUS
                    EQUIVALENT MACHINE LANGUAGE OBJECT CODED
                    INSTRUCTINS AND MEMORY ADDRESS ASSIGNMENTS FOR
                    EACH INSTRUCTION ( SOURCE + OBJECT ).

  ASSEMBLY CODE:    SAME CONTENT AS ASSEMBLY LISTING BUT HAND ASSEMBLED.

  SOURCE LISTING:   SOFTWARE PROGRAM LISTING RESULTING FROM COMPUTER
                    SOFTWARE CONTROLLED ASSEMBLY PROCESS THAT INCLUDES
                    ASSEMBLY LANGUAGE SOURCE CODED INSTRUCTIONS WITH
                    COMMENTS. SOMETIMES, LINE STATEMENT NUMBERS ARE
                    INCLUDED FOR EACH INSTRUCTION.

  SOURCE CODE:      SAME CONTENT AS SOURCE LISTING BUT HAND ASSEMBLED.

  OBJECT LISTING:   SOFTWARE PROGRAM LISTING RESULTING FROM COMPUTER
                    SOFTWARE CONTROLLED ASSEMBLY PROCESS THAT ONLY
                    INCLUDES MACHINE READABLE OBJECT CODED INSTRUCTIONS
                    AND MEMORY ADDRESS ASSIGNMENTS.

  OBJECT CODE       SAME CONTENT AS OBJECT LISTING BUT HAND ASSEMBLED.

  HARD COPY:        XEROX OR PRINTED COPY.

  CODE:             HAND ASSEMBLED CODE ( SOURCE, OBJECT, OR ASSEMBLY
                    CODE ).

  LISTING:          COMPUTER FORMATED LISTING.

  DUMP:             COMPUTER MEMORY DUMP.
```

Software Bugs

MODIFICATIONS TO DR. WANG'S PALO ALTO TINY BASIC

Dear Editor:

I have discovered the following errors in "Dr. Wang's Palo Alto Tiny Basic" as described in the December 1976 issue:

1. The ASCII code for Escape is 1B (hex) rather than 7D, which is the code for "] ". This occurs in the GETLN routine at address 0514.

2. The INPUT command will not always work as a direct command since direct commands and input data are both stored in the same area of memory, starting at BUFFER. Thus, input data, if long enough, could overwrite remaining portions of the INPUT command.

3. The CHGSGN routine does not work properly for an argument of zero, causing error messages to be printed for expressions such as -0 or 0*(-1). This problem can be cured with the following modification to the CHGSGN routine:

```
CHGSGN: MOV  A,H ;Test for zero argument
        ORA  L
        RZ        ;take no action for zero argument
;continue at this point with the entire original version of
;CHGSGN routine
```

Except for a few obscure programming tricks which could have been explained in the comments, such as using a two byte MVI instruction for "skip the next byte", I found the program listing fairly easy to understand.

Mark Hilmantel
Nashua, NH

MSO PROGRAMS

CPU TYPE	SYMBOLIC NAME	DESCRIPTIVE NAME	MSD # & MEDIA	PACK	REV #	+CALIF. TAX(*) +USA POSTAGE(:)
6502	APPLECO	6502 APPLE COMPUTER DISASSEMBLER ØY ALLEN ØAUM & STEPHEN WOZNIAH-INTERFACE AGE, SEPT. 1976, VOL.1,#10.	1-TEXT	<		5.00+0.30+1.00
			1-HCAL	<		INC. WITH TEXT
			1-PACK	↑		
B080	LPT11HF	LOAO 0080 PAPER TAPE IN INTEL HEX FORMAT BY BURT HASHIZUME-INTERFACE AGE, OCT. 1976, VOL.1,#11.	2-PTAL	<	0	8.00+0.48+2.00
			2-TEXT	<		3.00+0.18+1.00
			2-HCAL	<		INC. WITH TFXT
			2-PACK	↑		
8080	ØFWOA	R080 ØINARY FILES WITH OPTIONAL AUTOSTAHT BY WILLIAM H. JOROAN-INTERFACE AGE, DCT. 1976, VOL.1,#11.	3-PTAL	<	B	8.00+0.48+1.00
			3-PTDO	<		INC. WITH PTAL
			3-TEXT	<		3.00+0.18+1.00
			3-HCAL	<		INC. WITH TEXT
			3-PACK	↑		
6R00	MINOPS	MIN OPERATING SYSTEM ØY ED KEITH & OENNIS HESCOX-INTERFACE AGE, DCT. 1976, VDL.1,#11. PTAL+ INCLUDES OPERATING INSTRUCTIONS, PAPER TAPE FORMAT AND SAMPLE RUN	4-PTAL+	<	0	R.00+0.48+2.00
			4-PTDD	<		INC. WITH PTAL
			4-TFXT	<		2.00+0.12+1.00
			4-HCAL	<		INC. WITH TFXT
			4-PACK	↑		
R080	D8BDP	DR. 8FATTIE'S ØASIC OIET PLANNING BY DR. ØEATTIE-INTERFACE AGE, OCT. 1976, VOL.1,#11.	5-TEXT	<	0	3.00+0.18+1.00
			5-HC8L	<		INC. WITH TEXT
			5-PTØL	<		8.00+0.48+2.00
			5-PACK	↑		
6800	EZMERPS	ECHD 1, ZEHD MEMOHY, FCHO REVFRSE & PRINT SUBHOUTINES ØY HOWARD ØERFNBON-INTFRFACE AGE, OCT. 1976, VOL.1,#11.	6-PTAL	<	0	5.00+0.30+1.80
			6-TEXT	<		1.00+0.06+1.00
			6-HCAL	<		INC. WITH TEXT
			6-PACK	↑		
R080	ESP-1	FSP-1 SOFTWARE PACKAGE ØY MICHAEL SHRAYEH-INTERFACE AGE, OCT. 1976, VOL.1,#11. PTGR IS PAPER TAPE COPY OF GRAMMAR.	7-PTOD	<	%0	30.00+1.80+1.50
			7-MAN	<		INC. WITH PTOO
			7-CTDO	<		30.00+1.80+1.58
			7-MAN	<		INC. WITH CTOD
			7-PTGR	<		5.00+0.30+1.50
			7-HCGR	<		INC. WITH PTGR
			7-PACK	↑		
R0R0	PTSP-1	PROCESSDR TECHNOLOGY SOFTWARE PACKAGE NO. 1 SUMMAHY ØY R. A. STEVENS-INTERFACE AGF, DCT. 1976, VOL.1,#11.	8-PTGH	<	%0	5.00+0.30+1.50
			R-TEXT	<		INC. WITH PTTL
			8-PACK	↑		
R0R0	FRAMMT	EXHAUSTIVF R0RB RAM MFMORY TEST PROGRAM ØY T.F.TRAVIS -INTERFACE AGE, NOV. 1976, VOL.1,#12.	9-PTAL	<	0	6.00+0.36+2.00
			9-PTOO	<		INC. WITH PTAL
			9-TEXT	<		2.00+0.12+1.00
			9-HCAL	<		INC. WITH TEXT
			9-HCOD	<		INC. WITH TEXT
			9-PACK	↑		
6800	MFMOMP-1	SWTPC 6800 MFMORY DUMP PROGRAM MEMDMP-1 BY GARY KAY-INTEHFACF AGE, NOV. 1976, VOL.1,#12.	10-PTAL	<	0	5.00+0.30+1.00
			10-PTSL	<	0	8.00+0.48+1.00
			10-PTOO	<		INC. WITH PTSL
			10-TFXT	<		1.00+0.06+1.00
			10-HCAL	<		INC. WITH TEXT
			10-PACK	↑		
6R00	ROBIT-1	SWTPC 680B ROTATING BIT RAM MFMORY OIAGNOSTIC PROGRAM ROØIT-1 BY GARY KAY-INTERFACE AGE, NOV. 1976, VOL.1,#12.	11-PTAL	<	0	5.00+0.30+1.00
			11-PTSL	<	0	8.00+0.48+1.08
			11-PTOO	<		INC. WITH PTSL
			11-TEXT	<		1.00+0.06+1.88
			11-HCAL	<		INC. WITH TEXT
			11-PACK	↑		
6808	MEMCDN-1	SWTPC 680B SHORT MFMORY AODRESS CONVFRGFNCE PROGRAM MEMCON-1 BY GARY KAY-INTERFACE AGE, NOV. 1976, VOL.1,#12.	12-PTAL	<	0	5.00+0.30+1.00
			12-PTSL	<	0	8.00+0.40+1.08
			12-PTOO	<		INC. WITH PTSL
			12-TEXT	<		1.00+0.06+1.80
			12-HCAL	<		INC. WITR TEXT
			12-PACK	↑		
6H00	BJIR	BLACKJACK IN BASIC PROGHAM ØY EO KEITH & DENNIS HESCOX. THE BJIB PAPER TAPE OBJECT CODE REQUIRES ROBERT UITERWYK'S SWTPC MICROBASIC OPERATING SYSTEM-INTERFACE AGE, NOV. 1976, VOL.1,#12. PTBL+ INCLUOES SAMPLE RUN, INSTRUCTIONS, LIST OF VARIAØLES AND LIST DF ROUTINES.	13-PTBL		0	9.00+0.54+2.00
			13-PTBL+	<		12.00+0.72+2.00
			13-TFXT	<		2.00+0.12+1.00
			13-HCBL	<		INC. WITH TEXT
			13-PACK	↑		
6502	RFPR	REVISEO FLDATING POINT ROUTINES FDR 6502* BY RDY RANKIN & STEVF WOZNIAK - INTFRFACE AGF, NOV. 1976, VOL.1,#12. NOTE * - ORIGINAL MATH PACHAGE FIRST APPEARED IN DR. OOBB'S JOURNAL, AUG. 1976, VOL.1,#7.	14-PTOO	<	1	5.00+0.30+1.00
			14-PTAL	<		9.00+0.54+2.00
			14-PTSL	<		10.00+0.60+2.00
			14-TFXT	<		2.00+0.12+1.00
			14-HCAL	<		INC. WITH TEXT
			14-PACK	↑		
6800	HISPOMUP	RIGH SPEFO OOUBLE PRFCISON MULTIPLICATION SUØROUTINF-RISPOMUP BY PERMISSION ANO COURTESY OF MOTOROLA'S M68BB USER GROUP LIØRARY-INTFRFACF AGE, NOV. 1976, VOL.1,#12.	15-PTAL	<	0	8.00+0.48+1.00
			15-TEXT	<		1.80+0.06+1.00
			15-HCAL	<		INC. WITH TEXT
			15-PACK	↑		
6800	DIV16	REFNTRANT 16 BIT DIVIOE SUBROUTINF - OIV16 BY PFRMISSION AND COURTESY OF MOTOROLA'S M6800 USER GROUP LIBRARY- INTFRFACE AGF, NOV. 1976, VOL.1,#12.	16-PTAL	<	1	8.00+0.4R+1.00
			16-TFXT	<		1.00+0.06+1.00
			16-HCAL	<		INC. WITH TFXT
			16-PACK	↑		
6800	RENTMUP	REFNTRANT DOUBLF PRFCISION MULTIPLICATION SUBROUTINF-RENTMUP 8Y PERMISSION ANO COURTFSY OF MOTOROLA'S M6800 USFR GROUP LI8RARY-INTERFACE AGE, NOV. 1976, VOL.1,#12.	17-PTAL	<	0	8.00+0.48+1.00
			17-TEXT	<		1.00+0.06+1.00
			17-HCAL	<		INC. WITH TEXT
			17-PACK	↑		
8080	HDMEC	COMPUTEH OH CONTROLLER BY TERRY ØENSON, INTEL - INTERFACE AGE, SEPT. 1976, VOL.1,#18.	18-PTAL	<	0	5.00+0.30+1.00
			18-PTSL	<		5.00+0.30+1.00
			10-TEXT	<		1.00+0.06+1.88
			18-HCAL	<		INC. WITH TEXT
			18-PACK	↑		
R0R0	LCST	STARTREK ØY LYNN COCHRAN-INTERFACE, JUNE 1976, VOL.1,#7.	19-PTBL	<	0	7.00+0.42+1.00
			19-TEXT	<		3.00+0.18+1.00
			19-HCØL	<		INC. WITH TEXT
			19-PACK	↑		
80RB	WSPG	WORO SEARCH PUZZLE GENERATOR BY RICHARD S. EDELMAN - INTERFACE, JULY 1976, VOL.1,#R.	20-PTBL	<	B	6.00+0.36+1.00
			20-TEXT	<		2.00+0.12+1.00
			2B-HCØL	<		INC. WITH TEXT
			20-PACK	↑		
R080	PG0IORHY	ØIORHYTHM ØY PAUL GREEN - INTERFACE AGF, AUG. 1976, VDL.1,#9.	21-PTØL	<	0	6.00+0.36+1.00
			21-TEXT	<		1.00+0.12+1.00
			21-HCØL	<		INC. WITH PTØL
			21-PACK	↑		
R000	WD0IORHY	ØIORHYTHMS IN PRACTICE ØY WILLIAM L. DDNHAN, M.O. - INTERFACE AGE, AUG. 1976, VOL.1,#9.	22-PTBL	<	0	0.00+0.48+2.00
			22-TEXT	<		2.00+0.12+1.00
			22-HCBL	<		INC. WITH TEXT
			22-PACH	↑		
80R0	REBJ	BLACKJACK ØY RICHARO S. EDELMAN - INTERFACE AGF, AUG. 1976, VDL.1,#9.	23-PTØL	<	0	6.00+8.36+1.00
			23-TEXT	<		1.00+0.06+1.00
			23-HCBL	<		INC. WITH TEXT
			23-PACK	↑		
R080	ØLUFF	ØLUFF BY PHIL FFLOMAN & TOM HUGE - INTERFACE AGE, SEPT. 1976, VOL.1,#10.	24-PT8L	<	0	6.80+0.36+1.00
			24-TEXT	<		1.00+0.06+1.00
			24-HCØL	<		INC. WITH TEXT
			24-PACK	↑		
6888	HA0SIM0	HELATIVF ADORFSS ØACK-STEPPER IN MICRO-ØASIC BY J. HUFFMAN - INTERFACE AGE, DFC. 1976, VOL.1,#13.	25-PTBL	<	0	5.00+0.30+1.00
			25-HCØL	<		1.00+0.06+1.08
			25-TEXT	<		INC. WITH HCØL
			25-PACK	↑		
6R00	TEFT6R00	TEXT EDITDR FDR THE SWTPC-6R00 ØY MARK 8DRGERSON - INTERFACE AGE, DFC. 1976, VOL.1,#13. HCAL IS CDPY OF FULL SIZF ASSEMØLY LISTING.	26-PTAL	<	0	15.00+0.90+2.80
			26-PTOO	<		18.88+0.60+2.08
			26-HCAL	<		3.80+0.18+1.50
			26-TEXT	<		2.00+0.12+1.25
			26-PACH	↑		
R080	WPATRX	WANG'S PALO ALTO TINY BASIC BY ROGER RAUSKOLB - INTERFACF AGF, DEC. 1976, VOL.1,#13. HCAL & HCSL ARE COPIES OF FULL SIZE COOF	27-PTSL	<	0	28.00+1.28+3.00
			27-PTOD	<		10.00+0.60+2.00
			27-HCAL	<		4.00+0.24+1.50
			27-TFXT	<		INC. WITH HCAL
			27-HCSL	<		4.00+0.24+1.58
			27-PACK	↑		
80RB	LLL0I	LLL 80R0 ØASIC INTERPRFTER GRAMMAR ØY JERRY ØARØER & ROYCF ECKARD - SUBMITTED ØY E.R. FISHER - INTERFACE AGE, DEC. 1976,VOL.2,#1(PART 1). JAN. 1977,VOL.2,#2(PART 2), FER. 1977,VDL.2,#3(PART 3), MARCH 1977,VOL.2,#4(PART 4). TEXT1 IS PART 1, TEXT2 IS PART 2, ETC. HCAL2,3, & 4 ARE FULL SIZF XEROX COPIFS OF ASSEMBLY PROGRAM LISTINGS OF PARTS 2,3, & 4.	2R-TEXT1	<	0	5.00+0.30+2.00
			2R-HCAL2	<		5.00+0.30+2.08
			28-TEXT2	<		3.00+0.18+2.00
			20-HCAL3	<		5.00+0.30+2.80
			20-TEXT3	<		3.00+0.10+2.00
			28-TFXT4	<		3.00+0.18+2.00
			2R-HCAL4	<		3.00+0.1R+2.00
SC/MP	NIHL	NIBL-NATIONAL'S TINY RASIC GHAMMAR FOR SC/MP BY PHIL ROYØAL - INTFRFACE AGF, DEC. 1976, VOL.2, #1. ASSEMBLY LISTING PUBLISHED JAN. 1977, VDL.2,#1.	29-TEXT	<	0	5.08+0.38+2.00
			29-HCAL	<		18.80+3.00+2.00
			29-PTSL	<		10.08+3.08+2.08
			29-PTOO	<		5.00+1.50+1.08
			29-PTGR	<		2.00+0.12+1.88
			29-PACK	↑		
SC/MP	MWBAGFLS	BAGFLS BY OR. MARVIN WINZINKEAD BY PFRMISSION & COURTESY OF NATIONAL SEMICONDUCTOR - INTERFACF AGE, OFC. 1976, VOL.2,#1.	30-PTBL	<	B	5.80+0.38+2.00
R080	AMS80	AMSAT 8080 STANDARO OEBUG MONITOR BY RICHARO C ALLEN & JDF KASSFR - BYTF # 13, SEPT. 1976, VOL.2,#1. SUBMITTED BY JOE KASSFR.	31-PTSL	<	2	15.08+0.98+2.08
			31-PTOD	<		5.80+8.30+2.00
			31-PACH	↑		
6R00	BAFCMP	BASIC ALGORITHMS FOR COMMON MATH FUNCTIONS BY MICHAFL P. BURTON - INTERFACE AGE, JAN. 1977, VOL.2,#2.	32-PTBL	<	1	6.00+0.36+1.00
			32-TFXT	<		2.80+8.12+1.00
			32-PACK	↑		
R080	FCMSO	MICROCOMPUTER STOCK OPTIONS BY EDWARD CHRISTIANSON - INTERFACE AGF, FFB. 1977, VOL.2,#3.	33-PTRL	<	0	15.00+0.90+2.00
			33-HCHLF			5.80+0.30+2.00
			33-HCBLF	<		INC. WITH PTØL
			33-TFXT	<		5.00+0.30+2.00
			33-PACK	↑		
H080	RMRNG	RANDOM NUMBER GENERATOR 8Y 8OB MARTIN - INTERFACF AGE, FEB. 1977, VOL.2,#3.	34-PTAL	<	0	7.80+0.42+2.00
			34-PTSL	<		6.00+0.36+2.00
			34-TFXT	<		2.00+0.12+1.00
			34-HCALF			4.00+0.24+1.00
			34-RCALF	<		INC. WITH PTAL
			34-PACK	↑		
H0H0	RNDFGCST	RND FUNCTION GENERATOR CHI-SQUARF TFST PROGRAM 8Y 8OB MARTIN - INTERFACF AGF, FFB. 1977, VOL.2,#3.	35-PTHL	<		4.00+0.24+1.00
			35-HCBLF	<		INC. WITH PTBL
			35-PACK	↑		
H0H0	TTMOCSR	8080 MEMORY OBJECT CODF SFARCH ROUTINF BY T. F. TRAVIS - INTERFACE AGF, FFB. 1977, VOL.2,#3.	36-PTAL	<	0	5.00+0.30+1.00
			36-PTSL	<		5.00+0.30+1.00
			36-TEXT	<		1.00+0.06+1.00
			36-HCALF	<		INC. WITH TFXT
			36-HCALF			2.00+0.12+1.00
			36-PACK	↑		
8080	TOOMP	8080 OCTAL MONITOR PROGRAM BY THOMAS F. DOYLF - INTFRFACF AGF, FFB. 1977, VOL.2,#3.	37-PTAL	<	0	8.00+0.48+2.00
			37-PTSL	<		8.00+0.48+2.00
			37-TFXT	<		2.00+0.12+1.00
			37-HCALF			4.00+0.24+1.00
			37-HCALF	<		INC. WITH PTAL
			37-PTOO	<		5.00+0.30+1.50
			37-PACK	↑		
H080	LLLBFPMP	LLLBASIC FLOATING POINT MATH PACKAGE BY DAVID MFAD & MODIFIED BY HAL BRAND AND FRANK OLKFN - INTFRFACF AGE, FFB. 1977, VOL.2,#3.	38-TFXT	<	0	3.00+0.18+2.00
			38-HCALF	<		5.00+0.12+2.00

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8080	Z80MFRP	Z80 MITS 12K EXTENOFO BASIC PATCHES BY MARTIN O. GRAY - INTFRFACE AGE, MAHCH 1977, VOL.2,#4.	39-TFXT < 0 39-HCALF < 39-PACK †	1.00+0.06+1.00 1.00+0.86+1.00
6502	HJ0AST	6502 APPLE STAH-TREK BY HOBEHT J. 0ISHOP -	40-TEXT < 0 40-HC0L < 40-PACK †	3.00+8.18+1.00 INC. WITH TEXT
6800	AMIPROTO	AMI'S PRDTO OEVELOPMENT SOFTWAHE FOH EVK SERIES PROTOTYPING 0OARDS BY PERMISSION ANO COUHTESY OF AMFHICAN MICHOSYSTEMS EOITEO 0Y R.A.STEVENS- INTFRFACE AGE, FEB. 1977, VOL.2,#3.	41-TEXT < 0 41-HCALF < 41-PACK †	3.00+0.18+1.00 5.00+0.30+2.00
8080	CONSOL	CONSOL 1K RESIOENT OPERATING SYSTEM BY PERMISSION ANO COURTESY OF PROCFSSOH TECHNOLOGY- INTERFACE AGE, JAN. 1977, VOL.2,#2.	42-TEXT < 0 42-HCALF < 42-PACK †	3.00+0.18+1.00 5.00+0.30+2.00
8080	OOT-80	LLL BASIC OCTAL OEBUGGING PROGRAM BY E. R. FISHEH- INTERFACE AGE, MARCH 1977, VOL.2,#4.	43-TEXT < 0 43-HCALF < 43-PACK †	3.00+0.18+2.00 5.00+0.30+2.00
6K00	(HS)•3	HESIOFNT 6800 RFENTHANT ᵉˡF-HELATIVF SU0ROUTINF PACKAGE FOR EVK 6000 MICHOCOMPUTEH BOAHOS 0Y PFRMISSION ANO COURTESY OF AMEKICAN MICHOSYSTEMS EOITEO BY R.A. STEVFNS- INTEHFACE AGE, MARCH 1977, VOL.2,#4.	44-TFXT < 0 44-HCALF < 44-PACK †	3.00+0.18+1.00 5.00+0.30+2.00
6800	EXMON	6800 MIK0UG EXTFNOEO MONITOR SYSTFM BY MICHAEL BUHTON- INTFRFACE AGE, APRIL 1977, VOL.2,#5.	45-TEXT < 0 45-HCALF < 45-PTAL < 45-PTOD < 45-PACK †	2.00+0.12+1.00 3.00+0.18+1.50 9.00+0.54+2.00 5.00+0.30+2.00
8080	LMCOS	8080 CASSETTF OPEHATING SYSTEM (COS) BY LORIN MOHLEH- INTFHFACE AGE, APRIL 1977, VOL.2,#5.	46-TEXT < 46-PTSL < 46-HCALF < 46-PACK †	3.00+0.18+1.00 10.00+0.60+2.00 5.00+0.30+1.00
6888	MHFTIHFC	MOTOROLA 6800 HFX FORMAT TO INTEL FORMAT SOFTWARF CONVERTER 0Y FLOYO NOHDIN-	47-TEXT < 0 47-PTAL < 47-PTSL < 47-PTOO < 47-HCALF < 47-HCOOF < 47-PACK †	1.00+0.06+1.00 5.00+0.30+2.00 5.00+0.30+2.00 3.00+0.18+1.00 3.00+0.18+1.00 INC. WITH HCAL
8080	MMGTEW	GRAPHICS- THE EASY WAY BY MARVIN MALLON- INTEHFACE AGE. MARCH 1977, VOL.2.#4.	48-TEXT 0 48-HCBLF	3.00+0.10+1.00 5.00+0.30+1.00
8080	C0MS	BYTEMOVER SOFTWARE FOR THE CROMEMCO 0K BYTESAVER BOARD - PERMISSION AND COURTESY OF CROMEMCO EOITEO BY HOGER EOFLSON- INTERFACE AGE, JAN. 1977, VOL.2,#2.	49-TEXT 0 49-HCAL	5.00+0.30+1.00 INC. WITH TFXT
8080	FNOCOA	8080 OBJECT CODE OIS-ASSEMBLER BY FLOYO L. NOROIN- STANOARO VERSION HANOLFS UP TO 1K LABLES & ASSIGNS SYMBOLIC NAMES. ASCII CHAHACTER LIST PIN POINTS EMBEOOEO TA0LES. INCLUOES BOTH ASSEMBLY ANO SOURCE OUTPUT MOOES VIA YOUH OUTPUT ORIVERS. PROGRAM RESIOES AT TOP OF MEMORY. STANOARO VFRSIONS AVAILA0LE FOR 16K, 24K, 32K, 40K ANO 64K BYTFS OF MEMORY. OTHER VERSIONS WITH AOOITIONAL LABLE SPACE ANO/OH OIFFERENT MEMOHY SIZE ARE AVAILA0LE.	50-PTOO <%0 50-MAN < 50-PACK †	40.00+2.40+2.00 5.00+0.30+1.00 45.00+2.70+3.00
6800	SWTPMB	SWTP'S 6800 MICHOBASIC VEH. 1.4 BY HOBEHT H. UITERWYK ANO BY PERMISSION & COUHTESY OF SOUTHWEST TECHNICAL PROOUCTS CORP. SWTPC 6800 COMPUTER NEWSLETTER #1, JUNE 1976.	51-PTOD 0	15.00+0.90+2.00
6800	EVKM0	SWTP'S 6800 MICHOBASIC VFR. 1.4 MOOIFIEO FOR AMI'S 6800 EVK MICROCOMPUTER 0OAROS BY STEVEN O. WALL.	52-PTOD 0	15.00+0.90+2.00
8080	CCOKEN	AHTIFICAL INTELLIGENCE TIC-TAC-TOE PROGRAM (OR MENACE OF THE MICROWORLO) 0Y KEN BERKUM -INTEPFACE AGE, MAHCH 1977, VOL.2,#4.	53-PTBL < 0 53-TEXT < 53-HCBL < 53-HCBL 53-PACK †	10.00+0.60+2.00 2.00+0.12+1.00 INC. WITH PTBL 2.80+0.12+1.00
6800	JHOOTWP	OAY OF THE WEEK PHOGHAM BY JIM HUFFMAN-'	54-PTBL < 8 54-TEXT < 54-HC0L < 54-HCBL 54-PACK †	6.00+0.36+1.00 1.00+0.06+1.00 INC. WITH PTBL 1.00+0.06+1.00
6800	JHCB0P	CHFCK0OOK BALANCER PHOGHAM BY JIM HUFFMAN -	55-PT0L < 0 55-TFXT < 55-HC0L < 55-HC0L 55-PACK †	6.00+0.36+1.00 1.00+0.06+1.08 INC. WITH PTBL 1.00+0.06+1.00

```
8080  HFXOUMP   INTFL HEX FORMAT PAPEH TAPE  56-PTAL < 1   B.00+0.48+2.00
                OUMP PROGRAM BY ALAN H.      56-PTSL <     6.00+0.4B+2.B0
                MILLER -                     56-PTOD <     5.00+0.30+1.00
                                             56-HCAL <     INC. WITH PTAL
                                             56-HCAL       2.00+0.12+1.00
                                             56-HCSL <     INC. WITH PTSL
                                             56-HCSL       2.00+0.12+1.00
                                             56-PACK +

8080  CONVERT1  NUMBER BASE CONVFHSION-      57-PTBL < 0   7.00+0.42+1.00
                NON OISC VERSION BY JOHN     57-TEXT <     2.00+0.12+1.00
                W. SWAIN-                    57-HCBL <     INC. WITH PTBL
                                             57-HCBL       1.00+0.06+1.00
                                             57-PACK +

0080  CONVFRT2  NUMBER BASE CONVERSION-      58-PTBL < 0   7.00+B.42+1.00
                DISC BASED VEHSION OF        5B-TEXT <     2.00+D.42+1.00
                CONVEHTI ABOVE BY JOHN       58-HCBL <     INC. WITH PTBL
                W. SWAIN -                   58-HCBL       1.00+0.06+1.00
                                             5B-PACK +

Z80   SERIAL    USER TTY HANOLER FOR THE     59-TEXT   0   3.00+0.18+1.00
                Z80 OELEVOPMFNT SYSTEM BY    59-HCAL       2.00+0.12+1.00
                HICHAHO E. MALY -

6880  MEMTFST   A BFTTER 6800 MFMORY TEST    60-PTAL < 0   8.00+0.48+2.B0
                BY ED KFITH-                 60-PTSL <     8.00+0.48+2.0B
                                             60-PTOD <     3.00+0.18+1.00
                                             60-TEXT <     2.00+0.12+1.00
                                             60-HCAL <     INC. WITH PTAL
                                             60-HCAL       2.00+0.12+1.00
                                             60-HCSL <     INC. WITH PTSL
                                             60-HCSL       2.00+0.12+1.00
                                             60-PACK +

8080  AMLIFE    JOHN CONWAY'S GAME OF LIFF   61-PTAL < 4  15.00+0.90+2.00
                PHOGRAMMFD BY ALAN R. MILLER 61-PTSL <    10.00+0.60+2.00
                                             61-PTOD <     5.00+0.30+1.00
                                             61-TFXT <     2.00+0.12+1.00
                                             61-HCAL <     INC. WITH PTAL
                                             61-HCAL       2.00+0.12+1.00
                                             61-HCSL <     INC. WITH PTSL
                                             61-HCSL       2.00+0.12+1.00
                                             61-PACK +

H080  SFSL      STAP LANFS PROGRAM BY        62-PTBL < 0  15.00+0.60+2.00
                STEVEN FAHFR -               62-HCBL <     2.00+0.12+1.00
                                             62-TFXT <     2.00+0.12+1.00
                                             62-HCBL <     INC. WITH PTBL
                                             62-HCBL       2.00+0.12+1.00
                                             62-PACK +
```

CONVERT MOTOROLA 6800 HEX FORMAT TO INTEL FORMAT

by Floyd Nordin

INTRODUCTION

For those that may have EPROM programming capability on 8080 equipment such as the Intel MDS-800 or the Intellec 8/MOD 80, but do not have it on the Motorola 6800 Exorciser, the following convert program will be of interest. This program is run on the 8080 equipment. It accepts characters from an input reader device such as a paper tape reader, TTY reader, or iCOM floppy. The file or tape that is read is expected to be in the Motorola hex object code format. (This format is different from Intel's and therefore can not be loaded into 8080 RAM directly.). This program then proceeds to read the Motorola format and converts it to the Intel hex format. It sends the characters to a punch device such as a paper tape punch, TTY punch, or iCOM floppy.

6800 HEX FORMAT TO INTEL'S FORMAT

Because iCOM's floppy directory and format is the same for both Intel 8080 (FDOS II) and Motorola 6800 (EDOS II) equipment, it is feasible to read a Motorola floppy with the Intel equipment. The steps one would take are the following. Plug the iCOM floppy into the Intel equipment. Insert an Intel FDOS II floppy to drive 0 which has the convert program object file on it. Insert a Motorola floppy in drive I which contains a Motorola formatted object file, which needs to be programmed into EPROMs. After calling up FDOS II give the command: RUNGO,CNVT,MOTFILE:1,INTELFILE

EPROM PROGRAMMING

A few seconds later the job is complete and one may now load the new converted file into RAM using the "RUN" command. Now one can get down to the business of programming the EPROMs.

Note that one can patch the program to contain different jump addresses to the reader input driver and/or punch output driver to obtain different I/O combinations.

ASSEMBLY PROGRAM LISTING

```
                ;
                ;
                ;
                ;
                        TITLE   'CONVERT MOTOROLA FORMAT TO INTEL FORMAT
                ;
                ;
                ; THE PURPOSE OF THIS PROGRAM IS TO CONVERT MOTOROLA
                ; OBJECT FILES HAVING MOTOROLA HEX FORMAT TO INTEL
                ; FORMATTED FILES.  THESE MAY THEN BE LOADED AND
                ; PROMS PROGRAMED USING INTEL MDS EQUIPTMENT.
                ;
                ;CNVT
                ;
                ;DEC 1976
                ;
                ; OPERATES UNDER THE ICOM FLOPPY 'RUNGO' CMND.
                ;   RUNGO.CNVT,MOTFILE,INTELFILE
                ;
                ; THIS PROGRAM IGNORES THE MOTOROLA 'HEADER' OR
                ; 'EOF' RECORDS.  IT FINDS AND CONVERTS ALL
                ; MOTOROLA OBJECT CODE-HEX DATA RECORDS IN THE MOT.
                ; FORMAT AND CONVERTS THESE LINE BY LINE INTO AN
                ; EQUIVALENT INTEL HEX FORMATTED LINE.  IT THEN
                ; WRITES THOSE TO A FLOPPY OUTPUT FILE.  MOT. FILES
                ; ARE TAKEN FROM AN INPUT READER OR INPUT FLOPPY FILE
                ; CHAR BY CHAR INTO THE 'A' REG.  IF A CARRY IS
                ; FOUND INDICATING THE END OF THE FILE, THE PROGRAM
                ; WRITES AN INTEL END OF FILE RECORD AND RETURNS
                ; TO FDOS THRU ITS 'UPDATE' ENTRY.
                ;
                ; THIS PROGRAM MAY BE PATCHED AT 101H & 102H FOR ANY
                ; OTHER READER INPUT DRIVER START ADDRESS.
                ;
                ;
0020                    ORG     20H
0020 31FF2F             LXI     SP,2FFFH
0023 C30901             JMP     START
                ;
                ;
0100                    ORG     100H
0100 C31FF8     RI:     JMP     0F81FH  ;READ A ASCII BYTE
0103 C321F8     WRT:    JMP     0F821H  ;WRITE A ASCII BYTE
0106 C336F8     EXIT:   JMP     0F836H  ;GO UPDATE FLOPPY DIR.
                ;
                ;
0109 CD5101     START:  CALL    RICH    ;GET A CHAR
010C FE53               CPI     'S'
010F C20901             JNZ     START
0111 CD5101             CALL    RICH
0114 FE31               CPI     '1'
0116 C20901             JNZ     START
                ;
                ; FOUND FRONT OF A DATA RECORD
                ;
0119 1600               MVI     D,0     ;INIT CHECKSUM ACCUM.
011B 0E3A               MVI     C,':'
011D CD0301             CALL    WRT     ;SEND INTEL START COLON
0120 CD5A01             CALL    RBYTE   ;GET 2 CHAR FROM MOT.
0123 5F                 MOV     E,A     ;SAVE READ BYTES CNTR-LOOP CNTR
0124 3D                 DCR     A
0125 3D                 DCR     A
0126 3D                 DCR     A
0127 CD7201             CALL    WBYTE   ;WRITE ADJUSD REC. LENGTH VALUE
012A CD5A01             CALL    RBYTE
012D CD7201             CALL    WBYTE   ;MS ADDR
0130 CD5A01             CALL    RBYTE
0133 CD7201             CALL    WBYTE   ;LS ADDR
0136 AF                 XRA     A
0137 CD7201             CALL    WBYTE   ;NULL
013A CD5A01     DATA:   CALL    RBYTE
013D C24B01             JNZ     DATA1   ;DATA BYTES
0140 AF                 XRA     A
0141 92                 SUB     D
0142 CD7201             CALL    WBYTE   ;WRITE CHECKSUM
0145 CD9B01             CALL    WCRLF   ;& CR LF
0148 C30901             JMP     START   ;GO FOR ANOTHER LINE
014B CD7201     DATA1:  CALL    WBYTE
014E C33A01             JMP     DATA
                ;
                ;
                ; UTILITY SUBROUTINES
                ;
0151 CD0001     RICH:   CALL    RI
0154 DAA601             JC      FINSH
0157 E67F               ANI     7FH
0159 C9                 RET
                ;
                ; READ 2 ASCII CHARS & CONVERT TO HEX IN 'A'
                ;
015A CD5101     RBYTE:  CALL    RICH
015D CD8901             CALL    ASCHX
0160 E60F               ANI     0FH
0162 07                 RLC
0163 07                 RLC
0164 07                 RLC
0165 07                 RLC
0166 47                 MOV     B,A
0167 CD5101             CALL    RICH
016A CD8901             CALL    ASCHX
016D E60F               ANI     0FH
016F B0                 ORA     B
0170 1D                 DCR     E
0171 C9                 RET
                ;
                ; WRITE 2 ASCII CHARS FROM HEX VALUE IN 'A'
                ;
0172 F5         WBYTE:  PUSH    PSW     ;SAVE A COPY
0173 0F                 RRC
0174 0F                 RRC
0175 0F                 RRC
0176 0F                 RRC
0177 CD9101             CALL    HXASC   ;MS NIBBLE 1ST
017A CD0301             CALL    WRT
017D F1                 POP     PSW
017E 4F                 MOV     C,A
017F 82                 ADD     D       ;BUMP CHECKSUM
0180 57                 MOV     D,A
0181 79                 MOV     A,C
0182 CD9101             CALL    HXASC   ;LS NIBBLE 2ND
0185 CD0301             CALL    WRT
0188 C9                 RET
                ;
                ; CHANGE ASCII IN 'A' TO HEX IN 'A'
```

```
                  ;
0189 D630         ASCHX:  SUI     '0'
018B FE0A                 CPI     10
018D F8                   RM
018E D607                 SUI     7
0190 C9                   RET
                  ;
                  ; CHANGE HEX IN 'A' TO ASCII IN 'C'
                  ;
0191 E60F         HXASC:  ANI     0FH
0193 C690                 ADI     90H
0195 27                   DAA
0196 CE40                 ACI     40H
0198 27                   DAA
0199 4F                   MOV     C,A
019A C9                   RET
                  ;
                  ; WRITE A CRLF
                  ;
019B 0E0D         WCRLF:  MVI     C,0DH
019D CD0301               CALL    WRT
01A0 0E0A                 MVI     C,0AH
01A2 CD0301               CALL    WRT
01A5 C9                   RET
                  ;
                  ; WRITE AN INTEL END OF FILE RECORD & FINISH
                  ;
01A6 CD9B01       FINSH:  CALL    WCRLF
01A9 0E3A                 MVI     C,':'
01AB CD0301               CALL    WRT
01AE AF                   XRA     A
01AF CD7201               CALL    WBYTE
01B2 AF                   XRA     A
01B3 CD7201               CALL    WBYTE
01B6 AF                   XRA     A
01B7 CD7201               CALL    WBYTE
01BA 3E01                 MVI     A,1
01BC CD7201               CALL    WBYTE
01BF 3EFF                 MVI     A,0FFH
01C1 CD7201               CALL    WBYTE
01C4 CD9B01               CALL    WCRLF
01C7 C30601               JMP     EXIT
```

```
ASCHX 0189     DATA1 014B     DATAL 013A     EXIT  0106
FINSH 01A6     HXASC 0191     RBYTE 015A     RI    0100
RICH  0151     START 0109     WBYTE 0172     WCRLF 019B
WRT   0103
```

OBJECT PROGRAM LISTING

```
0 BLOCK01 0
0 ASCHX 00189H
0 DATA1 0014BH
0 DATAL 0013AH
0 EXIT  00106H
0 FINSH 001A6H
0 HXASC 00191H
0 RBYTE 0015AH
0 RI    00100H
0 RICH  00151H
0 START 00109H
0 WBYTE 00172H
0 WCRLF 0019BH
0 WRT   00103H
 $
:0600200031FF2FC30901AF
:10010000C31FF8C321F8C336F8CD5101FE53C2093F
:100110001CD5101FF31C2090116000F3ACD030195
:10012000CD5A015F3D3D3DCD7201CD5A01CD7201E9
:10013000CD5A01CD7201AFCD7201CD5A01C24B0132
:10014000AF92CD7201CD9B01C30901CD7201C33ABB
:100150001CB0001DAA601167FC9CD5101CDB901AB
:10016000F60F0707070747CD5101CDB901F60FB01C
:100170001BC9F50F0F0F0FCD9101CD0301F14FB276
:100180005779CD9101CD0301C9D630FF0AF8D607C3
:10019000C9F60FC69027CE40274FC90E0DCD0301EB
:1001A0000E0ACD0301C9CD9B010F3ACD0301AFCD9F
:1001B0007201AFCD7201AFCD72013E01CD72013E31
:0A01C00011CD7201CD9B01C30601C3
:00000001FF
```

User TTY Handler for the Z-80 Development System

by Richard E. Maly

INTRODUCTION

Serial is a serial I/O routine with a software UART to provide user mode communication in the Z-80 Development System. The source may be assembled at any ORG address, provided the interrupt jump table is properly adjusted (see Reassembly). The interrupt handler is from Z-80 OS5.

Serial is made up of three subroutines and an interrupt handler which uses the Z-80 mode 2 to count bit times with the counter-timer circuit.

USING SERIAL AS PROVIDED

1. Serial will load from DEBUG starting at address 03F20H.

2. The routine is set up for 110 baud, and must be modified for other baud rates. The parameters are:

LOC	110 BAUD	300 BAUD	2400 BAUD
3FF0H	0AFH	0AFH	08FH
3FF1H	0A5H	0A5H	085H
3FF2H	04AH	01BH	036H
3FF3H	025H	0DH	01BH
3FF4H	05H	05H	06H

3. The user program must initialize the UART by a call setup, where setup EQU 03F4FH. Set up must be called each time USER MODE is entered, since the development system resets all peripherals on a break to monitor mode.
4. To output a character, the ASCII character must be in the A register. The calling sequence is:

   LD A (CHAR); CHAR is a memory LOC of the ASCII character CALL TTYOUT; CALL I/O driver. TTYOUT EQU 03F3BH.
5. To receive a character:

   CALL TTYIN; Get a character. TTYIN EQU 03F3BH.

   TTYIN will return with the character in the A register.
6. NOTE: TTYIN and TTYOUT save the HL register pair on the user assigned stack. The UART interrupt handler does not save registers, but instead uses the alternate register set.

If the user program uses the alternate registers, the driver should be modified or the alternate registers should be pushed on to the stack prior to calling TTYIN or TTYOUT. (see Reassembly).

7. The driver TTYOUT does not put out null characters (OOH) after a carriage return. The user should include code to output nulls on printing terminals where required to allow time for the mechanical carriage motion. LOC 3FF4H (RTNIDL) is set up as a constant for null characters. A typical output routine with nulls is:

```
PRINT   LD A (CHAR)       ; Get character
        CP OD             ;Test for cr
JR Z NULLS

PRINT   LD A (CHAR)       ;Get character
        CP OD             ; Test for cr
        JR Z NULLS        ; Yes it is
        CALL TTYOUT       ; No print
        RET
NULLS   CALL TTYOUT       ; Output cr
        LD A LINFD        ; Load a linefeed
        CALL TTYOUT       ; Output LF
        LD A 00           ; Load a null
        LD B RTNIDL       ; Number of Nulls
MORE    CALL TTYOUT       ;
        DJNZ MORE-$       ; Loop until done
        RET
```

TESTING THE UART

TESTTY is a simple echo driver with a starting address of 1000H load TESTTY and serial via DEBUG. Modify the speed parameters if required, and then GO 1000.

The user may now type in a string, and when a CR is typed, the program will print (ECHO) the string.

Reassembly: if the user wishes to reassemble the handler, serial source must be edited.

1. Line 04 must be changed to the new starting address (ORG address).
2. Line 120 must be changed to relocate the interrupt jump table address (ORG INTRUP). The jump table must be loaded at an address with the last 3 bits O (ADD = XXXOH or XXX8H) in order to properly load the CTC interrupt vector. Therefore ORG INTRUP (line 120) should be ORGXXXOH or XXX8H where XXXO or 8H does not interfere with the driver or the user program. One method of calculating ORG INTRUP is

   ORG Address + OC7 + N

   Where N is the offset required to put INTRUP at XXXOH or XXX8H
3. The calling address will be:

SETUP	CALL	SERIAL + 02FH
TTYOUT	CALL	SERIAL
TTYIN	CALL	SERIAL + 01BH
SERIAL	EQU	ADDRESS

4. To change the UART from use of alternate registers to use of the main registers. It is necessary to change the code at lines 56, 57, 97, and 98 of the source. This will also change the address of INTRUP.

A. Delete Lines 56, 57, and replace with:

PUSH AF
PUSH BC
PUSH HL

B. Delete lines 97 and 98, and replace with:

POP HL
POP BC
POP AF

This will add two bytes of code and ORG INTERUP = ORG Address + C9 + N

SERIAL PROGRAM LISTING

```
THIS IS A SAMPLE RUN OF THE PROGRAM SERIAL USIHO THE TESTTY ORIVER

05>0
>LSIL SERIAL
>L TESTTY
>G 1000
THIS IS A TEST OF THE PROGRAM SERIAL
THIS IS A TEST OF THE PROGRAH SERIAL
THIS IS A TEST OF THE RUBOUT TESTING NOW
THIS IS A TEST OP THE RUBOUT TESTING NO
THIS IS THE TEST OF THE CTRL PTESTING NOW
TESTING HOW

                 0001 ; TTY DRIVERS FOR USE WITH SOFTARE UART
                 0002 ; ENTER TTYOUT WITH CHARACTER IN A
                 0003 ; TTYIN EXITS WITH CHARACTER IN A
3F20             0004    ORG 03F20H
3F20   E5        0005 TTYOUT  PUSH HL
3F21   21EE3F    0006         LD HL FLAG
                 0007 ;
3F24   CB76      0008 TSTTY   BIT TTYBUS (HL)
3F26   20FC      0009         JR NZ TSTTY-$
3F28   32ED3F    0010         LD (TTYSAV+1) A
3F2B   3AF13F    0011         LD A (STCLK)
3F2E   D3F1      0012         OUT (CLK1) A
3F30   3AF23F    0013         LD A (WHOLE)
3F33   D3F1      0014         OUT (CLK1) A
3F35   CBF6      0015         SET TTYBUS (HL)
3F37   CBEE      0016         SET XMT (HL)
3F39   E1        0017         POP HL
3F3A   C9        0018         RET
                 0019 ;
3F3B   00        0020 TTYIN   NOP
3F3C   00        0021         NOP
3F3D   00        0022         NOP
3F3E   E5        0023         PUSH HL
3F3F   21EE3F    0024         LD HL FLAG
                 0025 ;
3F42   CB7E      0026 TSTRCV  BIT RCVCHR (HL)
3F44   28FC      0027         JR Z TSTRCV-$
3F46   3AEF3F    0028         LD A (CHAR)
3F49   CBBE      0029         RES RCVCHR (HL)
3F4B   CBBF      0030         RES PARITY A
3F4D   E1        0031         POP HL
3F4E   C9        0032         RET
                 0033 ;SETUP FOR SOFTWARE UART
                 0034 ;
3F4F   3EE8      0035 SETUP LD A 0E8H
3F51   00        0036  NOP
3F52   D3F0      0037     OUT (CLK0) A
3F54   3E3F      0038     LD A 03FH
3F56   ED47      0039     LD I A
3F58   21EE3F    0040     LD HL FLAG
3F5B   CBB6      0041     RES TTYBUS (HL)
3F5D   CBAE      0042     RES XMT (HL)
3F5F   CBBE      0043     RES RCVCHR (HL)
3F61   210000    0044     LD HL 0
3F64   3E00      0045     LD A 0
3F66   ED5E      0046     IM 2
3F68   FB        0047     EI
3F69   CD203F    0048     CALL TTYOUT
3F6C   C9        0049     RET
                 0050 ; THIS IS A SOFTWARE UART
                 0051 ;FOR THE Z-80 DEVELOPMENT SYSTEM
                 0052 ;IT IS CALLED BY SUBROUTINES TTYOUT AND
                 0053 ;TTYIN VIA INTERUPTS
                 0054 UART:
3F6D   FB        0055      EI
3F6E   D9        0056      EXX
3F6F   08        0057      EX AF AF'
3F70   ED4BEC3F  0058      LD BC (TTYSAV)
3F74   21EE3F    0059      LD HL FLAG
3F77   0C        0060      INC C
3F78   79        0061      LD A C
3F79   CB6E      0062      BIT XMT (HL)
3F7B   204A      0063      JR NZ XMIT-$
3F7D   FE01      0064     CP 1
3F7F   2008      0065     JR NZ NOT1-$
3F81   DBFF      0066 FIRST IN A (KBD)
3F83   E601      0067     AND MASK01
3F85   2837      0068     JR Z RETURN-$
3F87   1824      0069     JR RESET-$
3F89   FE02      0070 NOT1 CP 2
3F8B   200E      0071     JR NZ DATAIN-$
3F8D   3AF13F    0072     LD A (STCLK)
3F90   D3F1      0073     OUT (CLK1) A
3F92   3AF23F    0074     LD A (WHOLE)
3F95   D3F1      0075    OUT (CLK1) A
3F97   CBF6      0076     SET TTYBUS (HL)
3F99   1823      0077    JR RETURN-$
3F9B   DBFF      0078 DATAIN IN A (KBD)
3F9D   E601      0079    AND MASK01
3F9F   B0        0080    OR B
3FA0   0F        0081    RRCA
3FA1   47        0082    LD B A
3FA2   79        0083    LD A C
3FA3   FE0A      0084    CP 10
3FA5   2017      0085    JR NZ RETURN-$
3FA7   78        0086    LD A B
3FA8   32EF3F    0087    LD (CHAR) A
3FAB   CBFE      0088   SET RCVCHR (HL)
3FAD   CBB5      0089 RESET RES TTYBUS (HL)
3FAF   CBAE      0090    RES XMT (HL)
3FB1   3AF03F    0091    LD A (RESET1)
3FB4   D3F1      0092    OUT (CLK1) A
3FB6   3AF33F    0093    LD A (HALF)
3FB9   D3F1      0094    OUT (CLK1) A
3FBB   010000    0095    LD BC 0
3FBE   ED43EC3F  0096 RETURN LD (TTYSAV) BC
3FC2   08        0097    EX AF AF'
3FC3   D9        0098    EXX
3FC4   FB        0099    EI
3FC5   ED4D      0100    RETI
                 0101 XMIT:
3FC7   FE01      0102    CP 1
3FC9   2005      0103    JR NZ NOTSTP-$
3FCB   AF        0104    XOR A
3FCC   D3FF      0105    OUT (PTR) A
3FCE   18EE      0106    JR RETURN-$
3FD0   FE0A      0107 NOTSTP CP 10
3FD2   2808      0108    JR Z STOP-$
3FD4   FE0B      0109    CP 11
3FD6   2805      0110    JR Z RESET-$
3FD8   78        0111 DATOUT LD A B
3FD9   D3FF      0112    OUT (PTR) A
3FDB   0F        0113    RRCA
3FDC   47        0114    LD B A
3FDD   190F      0115    JR RETURN-$
3FDF   3E01      0116 STOP LD A 01
3FE1   D3FF      0117    OUT (PTR) A
3FE3   1809      0118    JR RETURN-$
3FE8             0119   ORG 03FE8H
3FE8   FF3F      0120 INTRUP DEFW 03FFFH
3FEA   6D3F      0121        DEFW UART
3FEC             0122 TTYSAV DEFS 2
3FEE             0123 FLAG   DEFS 1
3FEF             0124 CHAR   DEFS 1
                 0125 TTYPRM: ;FOR 300 BAUD CHANGE TO COMMENT VALUES
3FF0   AF        0126 RESET1 DEFB 0AFH; 0AFH
3FF1   A5        0127 STCLK  DEFB 0A5H ; 0A5H
3FF2   4A        0128 WHOLE  DEFB 04AH ; 01BH
3FF3   25        0129 HALF   DEFB 025H ; 00DH
3FF4   05        0130 RTNIDL DEFB 005H ; 005H
                 0131 ;
                 0132 ; FOR 2400 BAUD CHANGE TTYPRM TO/
                 0133 ; 0BFH
                 0134 ; 095H
                 0135 ; 036H
                 0136 ; 01BH
                 0137 ; 005H
                 0138 ;
                 0139 RCVCHR EQU 7
                 0140 XMT     EQU 5
                 0141 MASK01  EQU 1
                 0142 KBD     EQU 0FFH
                 0143 CLK1    EQU 0F1H
                 0144 TTYBUS  EQU 6
                 0145 PTR     EQU 0FFH
                 0146 CLK0    EQU 0F0H
                 0147 PARITY EQU 7
                 0148  END
```

TESTTY PROGRAM LISTING

```
                 0001 ; TEST ROUTINE FOR SOFTWARE UART
                 0002 ;    QUAY CORPORATION
                 0003 ;    P.O. BOX 386
                 0004 ;     FREEHOLD N.J.
                 0005 ;       07728
                 0006 ; THIS ROUTINE WILL ACCEPT CHARACTERS
                 0007 ; FROM A KEYBOARD AND UPON RECIEPT
                 0008 ; OF A CR WILL DO A LF AND ECHO THE
                 0009 ; STRING AS ENTERED.
                 0010 ; THE I/O HANDLER USES THE Z-80 INTERUPT
                 0011 ; MODE 2, AND IS FROM THE OSS MONITOR.
                 0012 ; UART USES THE ALTERNATE REGISTERS
                 0013 ; INSTEAD OF PUSH AND POP TO SAVE.
                 0014 ;
1000             0015 TESTTY ORG 1000H
1000   311F3F    0016        LD SP STACK
1003   CD4F3F    0017        CALL SETUP        ; INITIALIZE SYSTEM
1006   210000    0018        LD HL 0H          ; BUFFER IS ADD 0-BOT
1009   CD3B3F    0019 MORIN  CALL TTYIN        ; LOOK FOR INPUT
100C   FE0D      0020        CP 0DH            ; CR ?
100E   280C      0021        JR Z XMT-$        ; YES GO ECHO STRING
1010   FE7F      0022        CP 07FH           ; RUBOUT
1012   2833      0023        JR Z RUB-$        ; YES IGNORE CHARACTER
1014   FE10      0024        CP 10H            ; CRTL P ?
1016   2832      0025        JR Z DELETE-$     ; YES IGNORE LINE
1018   77        0026        LD (HL) A         ; STORE CHARACTER
1019   23        0027        INC HL            ; BUMP ADDRESS
101A   18ED      0028        JR MORIN-$        ; GET MORE INPUT
101C   CD3310    0029 XMT    CALL NULLS
101F   45        0030        LD B L            ; GET THE BYTE COUNT
1020   78        0031        LD A B
1021   A7        0032        AND A
1022   28E5      0033        JR Z MORIN-$
1024   210000    0034        LD HL 0H          ; SET BUFFER BACK
1027   7E        0035 MOROUT LD A (HL)         ; GET CHARACTER
1028   CD203F    0036        CALL TTYOUT       ; PRINT IT
102B   23        0037        INC HL            ; POINT TO NEXT CHARACTER
102C   10F9      0038        DJNZ MOROUT-$     ; MORE DATA ?
102E   CD3310    0039        CALL NULLS        ; OUTPUT A CR LF
1031   18D3      0040        JR (MORIN-3)-$    ; GET MORE DATA
1033   3E0D      0041 NULLS  LD A 0DH          ; GET A CR
1035   CD203F    0042        CALL TTYOUT       ; TRANSMIT IT
1038   3E0A      0043        LD A 0AH          ; GET A LF
103A   CD203F    0044        CALL TTYOUT       ; TRANSMIT IT
103D   0604      0045        LD B 04H          ; NULL COUNT
103F   3E00      0046 NULCT  LD A 0H           ; LOAD A NULL
1041   CD203F    0047        CALL TTYOUT       ; TRANSMIT IT
1044   10F9      0048        DJNZ NULCT-$      ; MORE NULLS ?
1046   C9        0049        RET
                 0050 STACK  EQU 03F1FH        ; STACK ADDRESS
                 0051 SETUP  EQU 03F4FH
                 0052 TTYIN  EQU 03F3BH
                 0053 TTYOUT EQU 03F20H
1047   2B        0054 RUB    DEC HL            ; SET PTR BACK
1048   18BF      0055        JR MORIN-$        ; GO GET NEW CHARACTER
104A   210000    0056 DELETE LD HL 0H          ; RESET BUFFER
104D   18BA      0057        JR MORIN-$        ; GET A NEW LINE
                 0058        END
```

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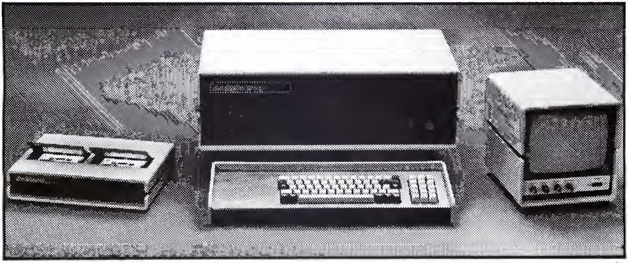

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CIRCLE INQUIRY NO. 84

Number Base Conversion Routine

by John W. Swain

INTRODUCTION

This program was written for use on my system to facilitate the conversion of numbers in one base to another. Two versions are presented in this article:

(1) A non disc version for interactive conversions
(2) A disc based version which allows converting a file written in one base to another base. This is useful if your assembler output is on OCTAL and you need 'BNPF' code to work with an EPROM programmer.

DESCRIPTION

The following programs give you the ability to convert from 'OCTAL', 'HEX', 'DECIMAL', and INTEL Corp. 'BNPF' code into any of the other codes.

These programs were written in Rev. 4.0 ALTAIR Extended BASIC (disc version) and may contain commands not found in other versions of BASIC.

Two of the following commands which may not appear in your version of BASIC are: (1) HEX$(X) and (2) OCT$(X).

The function 'HEX$(X)' gives the hexadecimal representation of the argument 'X'. The function 'OCT$(X)' gives the OCTAL representation of the argument 'X'.

For BASICs which don't contain these functions, the following code could be used. This is broken down into three parts:

(1) Must be placed at the front of the program.

```
10 DATA0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F
20 DIM H$(15)
30 FOR I = 0 TO 15
40 READ H$(I)
50 NEXT I
60 RESTORE
```

(2) To replace the function 'OCT$(X)' use the following code:

```
870 FOR I1 = 5 TO 0 STEP-1
872 T = (C + .1)/8↑I1
874 Y$ = Y$ + H$(T)
876 C = ((T-INT(T)*8 I1) + (.5*10 - I1)
878 NEXT I1
```

(3) To replace the function 'HEX$(X)' use the following code:

```
890 FOR I1 = 3 TO 0 STEP-1
892 T = C/16↑I1
894 Y$ = Y$ + H$(T)
896 C = (T-INT(T))*16↑I1
NEXT I1
```

Note: The line numbers are just for reference and must be changed to fit into the program you are using.

There are several other functions which may not be found in other versions of BASIC, and these are listed below with a brief description of their function:

(1) VAL(X$) Returns the numeric value of X$
(2) STR$(X) Returns a string variable of the argument 'X'
These two functions allow converting between string variables and single precision numbers.
(3) ASC(X$) Returns the decimal number equivalent of the ASCII character 'X$'
(4) IF—THEN—ELSE If the argument is true, the statement following the 'THEN' is used, however, if the argument is false, the argument following the 'ELSE' is used.

Please note that with proper modification, this program could read into an array from a paper or mag tape and output, back onto the same or different media, the converted code. With a disc system, it would be simply a matter of reading a file one record at a time and writing it back onto the disc in the converted format into another file.

The two versions presented below are:

(1) A non disc interactive program.
(2) A disc version currently residing on my system which contains program #1 coupled with the ability to use disc files.

PROGRAM SIZE

The size of the programs are as follows:

PROGRAM #	SOURCE	RUNNING
1	2.2 K	2.2 K
2	3.0 K	3.0 K

AUTHOR'S COMMENTS

The author would be interested in hearing from other readers of INTERFACE AGE concerning other types of applications oriented programs which you would like to see put into the MSD.

The author would be willing to write as many of these programs as his time allows and then place them in the MSD for use by all individuals concerned.

The author has had several microprocessor systems, the latest of which is an ALTAIR 8800B, with two floppy disc drives, 60K of memory, 2K of ROM, 2 serial ports, 4 parallel ports, a VDM-1, an ASR-33, and a high speed facit paper tape punch.

Any suggestions should be submitted in writing, with a brief description of its function, and any specialized formulas which the author may not be familiar. These should be sent to Bob Stevens of the MSD. I will then review them and then act accordingly.

All used suggestions will include the name of the person suggesting the routines and the configuration required to run the program.

There are two programs which are currently in the process of being written, and which I hope to publish and to release to the MSD for distribution. These are a 2704-2708 EPROM programmer-editor (17 possible commands) and a schematic of the programmer itself, with a complete text editing system for use in writing letters and magazine articles.

Let's hear your suggestions!

CONVERT-DISC VERSION BASIC LISTING

```
100 REM THIS PROGRAM TO BE RELEASED FOR PUBLIC DOMAIN
110 REM PROGRAM TO CONVERT FROM ONE BASE TO ANOTHER
120 REM WRITTEN BY JOHN W. SWAIN
130 REM
140 REM
150 REM
160 REM C = INTERMEDIATE BASE 10 INTEGER VALUE
170 REM Y$ = ANSWER IN THE FORMAT ASKED FOR
180 REM X$ = INPUT VALUE TO THE BASE X TO BASE 10 INTEGER CONVERSION
```

```
190 REM OTHER VARIABLES USED  I,J,C0,A$,N,T$,T,Y,X,Z$,Z2,Z1
200 REM ZZ$
210 Z$(1)="OCTAL":ZZ$(1)=" (0-177777)"
220 Z$(2)="HEX":ZZ$(2)=" (00-FFFF)"
230 Z$(3)="DECIMAL":ZZ$(3)=" (0-65535)"
240 Z$(4)="BNPF CODE":ZZ$(4)=""
250 PRINTTAB(10);"NUMBER CONVERSION ROUTINES"
260 PRINT"'O' ENDS THE CONVERSION ROUTINE YOU ARE IN."
270 E=0
280 PRINT"'S' ENDS THE PROGRAM."
290 PRINT"WHEN CONVERTING DISC FILES, AN INPUT ERROR IN BNPF FORMAT IS"
300 PRINT" CONVERTED TO 'Z2' AND WRITTEN ON THE DISC"
310 PRINT"BNPF CODE LIMITS YOU TO 8 BIT CODES (0-255 DECIMAL)"
320 FOR I=1 TO 4
330 PRINT"TO CONVERT FROM ";Z$(I);ZZ$(I);" ENTER ";I;
340 IF I<>4 THEN PRINT
350 NEXT I
360 INPUT Z1
370 PRINT
380 FOR I=1 TO 4
390 PRINT"TO CONVERT INTO ";Z$(I);ZZ$(I);" FROM ";Z$(Z1);" ENTER";I;
400 IF I<>4 THEN PRINT
410 NEXT I
420 INPUT Z2
430 PRINT
440 INPUT"IS INPUT ON A DISC FILE";Q$
450 IF LEFT$(Q$,1)="Y" THEN 1110
460 PRINT"WHAT IS YOUR VALUE IN ";Z$(Z1);
470 INPUT X$
480 PRINT:Y$=""
490 IF X$="O" THEN 260
500 IF X$="S" THENPRINT"BYE":END
510 ON E GOTO 850
520 ON Z1 GOSUB 570,730,830,850
530 ON Z2 GOSUB 950,970,990,1010
540 PRINT"THE ";Z$(Z2);" VALUE = ";Y$
550 PRINT
560 GOTO 460
570 X=VAL(X$):C0=0
580 FOR I= LEN(X$) TO 1 STEP -1
590 X=X/10
600 Y(I)=X-INT(X)
610 Y(I)=INT(Y(I)*10+.5)
620 X=INT(X)
630 NEXT
640 Y2=X-INT(X)
650 Y2=INT(Y2*10+.5)
660 Y(I)=INT(X)
670 FOR I=1 TO LEN(X$)
680 C0=C0*8
690 C0=C0+Y(I)
700 NEXT I
710 C=INT(C0)
720 RETURN
730 FOR J=1 TO LEN(X$)
740 Y$(J)=MID$(X$,J,1)
750 IF Y$(J)<="9" THEN T(J)=VAL(Y$(J)) ELSE T(J)=ASC(Y$(J))-55
760 NEXT J
770 C=0
780 FOR I=1 TO LEN(X$)
790 C=INT(C*16)
800 C=INT(C+T(I))
810 NEXT I
820 RETURN
830 C=INT(VAL(X$))
840 RETURN
850 C=0:E=0
860 IF LEFT$(X$,1)<>"B" OR MID$(X$,10,1)<>"F" THEN 940
870 FOR I=1 TO 8
880 T$(I)=MID$(X$,I+1,1)
890 NEXT I
900 FOR I=1 TO 8
910 IF T$(I)="P" THEN C=INT(C+(2↑(8-I)))
920 NEXT I
930 RETURN
940 PRINT"INVALID FIELD DELIMITERS":E=1:IF K1<>1 THEN 460 ELSE RETURN
950 Y$=OCT$(C)
960 RETURN
970 Y$=HEX$(C)
980 RETURN
990 Y$=STR$(C)
1000 RETURN
1010 N=0:Y$=""
1020 FOR I=0 TO 7
1030 IF INT(CAND2↑I) THEN A$(8-I)="P" ELSE A$(8-I)="N"
1040 NEXT I
1050 A$(0)="B"
1060 A$(9)="F"
1070 FOR I=0TO9
1080 Y$=Y$+A$(I)
1090 NEXT I
1100 RETURN
1110 PRINT:INPUT" INPUT FILENAME";GN$:K1=1:RN=0
1120 INPUT" DISC NUMBER";DN
1130 INPUT" OUTPUT FILE NAME";OF$
1140 INPUT" OUTPUT DISC NUMBER";OD
1150 OPEN "I",1,GN$,DN
1160 OPEN "O",2,OF$,OD
1170 IF EOF(1) THEN 1260
1180 INPUT #1,X$
1190 IF X$="" THEN 1170
1200 IF Z1=4 THEN GOSUB 1290
1210 ON Z1 GOSUB 570,730,830,850
1220 IF E=1 THEN PRINT"ON RECORD #";RN:E=0:C=0
1230 ON Z2 GOSUB 950,970,990,1010
1240 PRINT #2,Y$:RN=RN+1
1250 GOTO 1170
1260 CLOSE:INPUT"ANOTHER CONVERSION";Q$:K1=0
1270 IF LEFT$(Q$,1)="Y" THEN 440
1280 PRINT"BYE":END
1290 FOR I=1 TO LEN(X$)
1300 IF MID$(X$,I,1)="B" THEN X$=MID$(X$,I,10):RETURN
1310 NEXT I
1320 RETURN
```

CONVERT-NON DISC VERSION BASIC LISTING

```
100 REM THIS PROGRAM TO BE RELEASED FOR PUBLIC DOMAIN
110 REM PROGRAM TO CONVERT FROM ONE BASE TO ANOTHER
120 REM WRITTEN BY JOHN W. SWAIN
130 REM
140 REM
150 REM
160 REM C = INTERMEDIATE BASE 10 INTEGER VALUE
170 REM Y$ = ANSWER IN THE FORMAT ASKED FOR
180 REM X$ = INPUT VALUE TO THE BASE X TO BASE 10 INTEGER CONVERSION
190 REM OTHER VARIABLES USED  I,J,C0,A$,N,T$,T,Y,X,Z$,Z2,Z1
200 REM ZZ$
210 Z$(1)="OCTAL":ZZ$(1)=" (0-177777)"
220 Z$(2)="HEX":ZZ$(2)=" (00-FFFF)"
230 Z$(3)="DECIMAL":ZZ$(3)=" (0-65535)"
240 Z$(4)="BNPF CODE":ZZ$(4)=""
250 PRINTTAB(10);"NUMBER CONVERSION ROUTINES"
260 PRINT"'O' ENDS THE CONVERSION ROUTINE YOU ARE IN."
270 E=0
280 PRINT"'S' ENDS THE PROGRAM."
290 PRINT"BNPF CODE LIMITS YOU TO 8 BIT CODES (0-255 DECIMAL)"
300 FOR I=1 TO 4
310 PRINT"TO CONVERT FROM ";Z$(I);ZZ$(I);" ENTER ";I;
320 IF I<>4 THEN PRINT
330 NEXT I
340 INPUT Z1
350 PRINT
360 FOR I=1 TO 4
370 PRINT"TO CONVERT INTO ";Z$(I);ZZ$(I);" FROM ";Z$(Z1);" ENTER";I;
380 IF I<>4 THEN PRINT
390 NEXT I
400 INPUT Z2
410 PRINT
420 PRINT"WHAT IS YOUR VALUE IN ";Z$(Z1);
430 INPUT X$
440 PRINT:Y$=""
450 IF X$="O" THEN 260
460 IF X$="S" THENPRINT"BYE":END
470 ON E GOTO 810
480 ON Z1 GOSUB 530,690,790,810
490 ON Z2 GOSUB 910,930,950,970
500 PRINT"THE ";Z$(Z2);" VALUE = ";Y$
510 PRINT
520 GOTO 420
530 X=VAL(X$):C0=0
540 FOR I= LEN(X$) TO 1 STEP -1
550 X=X/10
560 Y(I)=X-INT(X)
570 Y(I)=INT(Y(I)*10+.5)
580 X=INT(X)
590 NEXT
600 Y2=X-INT(X)
610 Y2=INT(Y2*10+.5)
620 Y(I)=INT(X)
630 FOR I=1 TO LEN(X$)
640 C0=C0*8
650 C0=C0+Y(I)
660 NEXT I
670 C=INT(C0)
680 RETURN
690 FOR J=1 TO LEN(X$)
700 Y$(J)=MID$(X$,J,1)
710 IF Y$(J)<="9" THEN T(J)=VAL(Y$(J)) ELSE T(J)=ASC(Y$(J))-55
720 NEXT J
730 C=0
740 FOR I=1 TO LEN(X$)
750 C=INT(C*16)
760 C=INT(C+T(I))
770 NEXT I
780 RETURN
790 C=INT(VAL(X$))
800 RETURN
810 C=0:E=0
820 IF LEFT$(X$,1)<>"B" OR MID$(X$,10,1)<>"F" THEN 900
830 FOR I=1 TO 8
840 T$(I)=MID$(X$,I+1,1)
850 NEXT I
860 FOR I=1 TO 8
870 IF T$(I)="P" THEN C=INT(C+(2↑(8-I)))
880 NEXT I
890 RETURN
900 PRINT"INVALID FIELD DELIMITERS":E=1:GOTO 420
910 Y$=OCT$(C)
920 RETURN
930 Y$=HEX$(C)
940 RETURN
950 Y$=STR$(C)
960 RETURN
970 N=0:Y$=""
980 FOR I=0 TO 7
990 IF INT(CAND2↑I) THEN A$(8-I)="P" ELSE A$(8-I)="N"
1000 NEXT I
1010 A$(0)="B"
1020 A$(9)="F"
1030 FOR I=0TO9
1040 Y$=Y$+A$(I)
1050 NEXT I
1060 RETURN
```

SC/MP SEIKO PRINTER INTERFACE AND PROGRAM — SSEIKOPP

by Philip Roybal

INTRODUCTION

The computer hobbyist who sets up his first home system with somebody's microprocessor and a "glass teletype" discovers a serious limitation when he starts writing programs, or more precisely, when he starts debugging them. He finds that the typical video interface provides storage for about only 32 lines of display, 1/2 of which are usually visible at one time. Therefore, in *debug* mode he either spends much time writing things down or else he develops a good memory for subroutine entry points, tables of contents, etc. Eventually he feels the need for hard copy and a printer to produce it. This article discusses the hardware and software used to interface a low-cost Seiko printer with National Semiconductor's SC/MP microprocessor.

FEATURES OF SEIKO 310 PRINTER

The Model 310 Seiko Digital Printer (made by Shinshu Seiki Co., Ltd. of Japan) was chosen for this application because it is compact and readily available. In addition, it provides at low cost a handy set of features including:

- Single supply voltage (17V)
- Speed of 2-5 lines/second
- Choice of two print colors
- 16-column print format.

The printer mechanism consists of 16 12-character print wheels (figure 1) driven through individual clutches by a common shaft.

When a print command is sent to the printer, the wheels begin to rotate and a timing pulse ($T_0, T_1, T_2 \ldots T_{11}$) is generated for each character position of the wheels (figure 2). During the T_4 to T_6 interval, color information is transmitted to select the color of tape to be printed. When the position of a wheel corresponds to the selected symbol for that column, the print wheel is stopped and mechanically latched; thus, at the trailing edge of timing pulse T_{11}, all the print wheels are locked in position. When the platen print signal goes high, the selected characters for each column are transferred to the paper; then the paper is advanced. After completion of the print cycle, the motor drive signal is terminated and each print wheel returns to the initial blank (B) position.

INTERFACE HARDWARE

The SC/MP-to-printer interface (figure 3) is implemented via a special-purpose chip set that includes interface logic No. 1 (DS8693), interface logic No. 2 (DS8694), and two transistor arrays (DS8692). The DS8693 device contains the interface logic for the color solenoid driver, the motor driver, and seven of the column/character select solenoid drivers; the DS8694 chip contains the interface logic for eight column/character solenoid drivers plus the clock oscillator and timing-signal buffer. Each transistor array contains eight common-emitter output circuits. Each circuit features active pull down and each can sink up to 350 milliamperes of current.

Address decoding for the printer interface is performed by a BCD-to-decimal decoder (DM74LS138). Hexadecimal address X'0200 is assigned to access the printer; address assignments for interface control are as follows:

HEX ADDRESS	FUNCTION	REMARKS
0200	Printer Interface	
0201	Clock IN1	Used to load DS-8693 with print information for columns D10 through D16
0202	Clock IN2	Used to load DS-

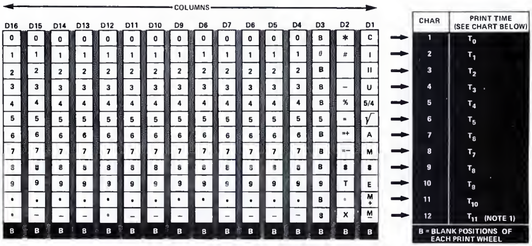
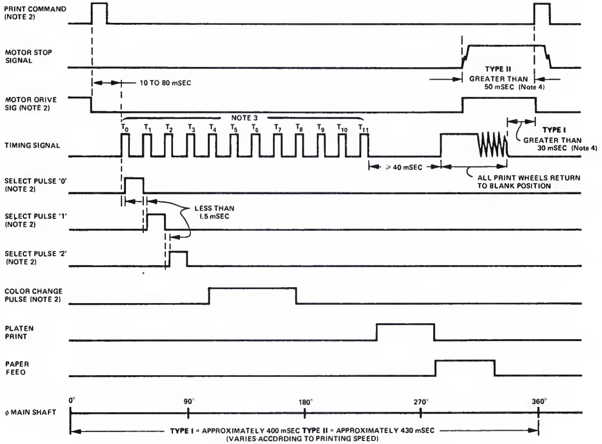


Figure 1.

The 16 12-character print wheels of the Seiko printer, with the timing pulse corresponding to each character.

		8694 with print information for columns D1 through D9
0203	Common Clock	Used to clear DS-8693 and DS8694
0204	Print	Used to issue PRINT COMMAND

In operation, the SC/MP CPU executes a STore command to Hex address X'0204, causing a PRINT signal to be sent to the Seiko printer. It then monitors Sense A, checking for the presence of a timing pulse. As the print wheels start turning and timing pulses are generated by the printer, the SC/MP compares information in the data buffer (X'0100—X'010F) against the code list for each column to determine what (if any) print wheels are to be stopped and latched at that print position. Then, shortly after the start of each timing pulse, the SC/MP will output two bytes of data through addresses X'0201 and X'0202. These bytes will contain zeros in bit positions corresponding to each



NOTES:

1. Printed 'Red' in columns D4 through D16 to represent negative result.
2. These signals are generated by SC/MP.
3. Time period between T_N and T_{N+1} = 13 to 25 mSEC.
4. For a 'Type I' timing cycle, implement a 30-millisecond delay between last trailing edge of 'Return' signal and leading edge of 'Print' command; for a 'Type II' timing signal, implement a 50-millisecond delay between leading edge of 'Motor Stop' signal and leading edge of 'Print' command.
5. For further detail on Model 310 DIGITAL PRINTER, refer to specification sheets and other documents of manufacturer (Shinshu Seiki Co., Ltd. of Japan); for further detail on devices DM 8693 and DM 8694, refer to specification sheets of National Semiconductor Corp.

Figure 2. These are the timing pulses that occur during a print cycle of the Seiko printer interface.

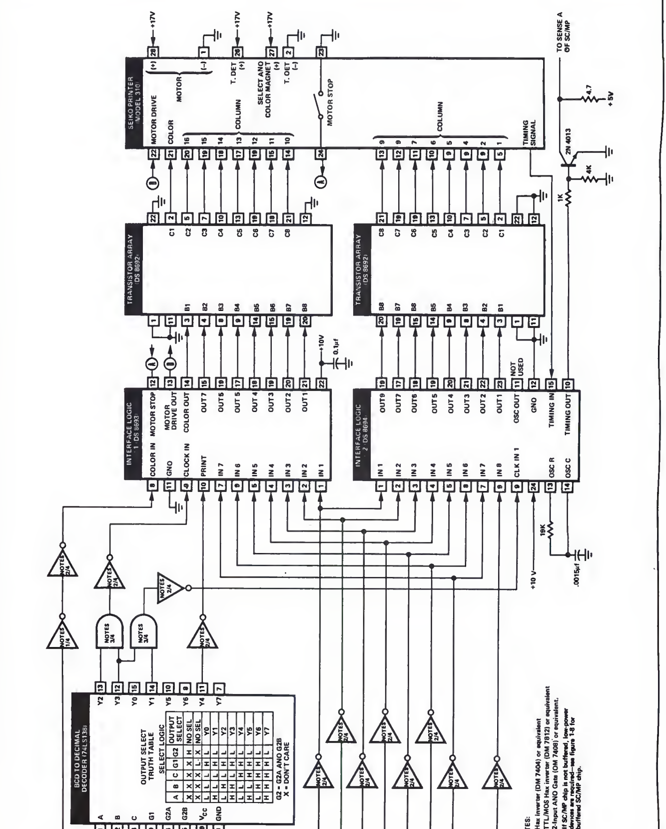


Figure 3. The SC/MP to Seiko Printer Interface.

print wheel to be latched at that time (figure 4). From this information, the DS8693/DS8694 logic elements generate select pulses for the printer.

(NOTE: The TTL-to-MOS inverters in the interface devices require that the column drivers be driven with a logic '0' for selection; that is, the print wheels lock into position at a particular timing pulse if the COLWORD bit corresponding to that position is a logic '0'.)

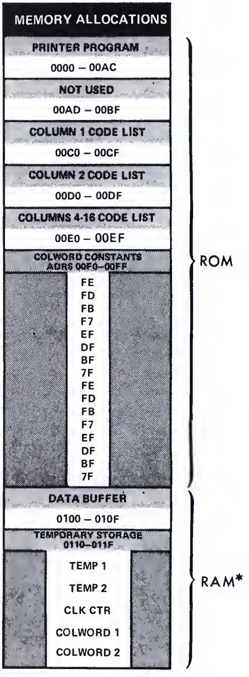
After the print wheel shaft has rotated through all twelve print positions and all print wheels are latched, the printer prints the line, advances the paper, and resets all print wheels. The SC/MP resets the interface elements, and is then ready to print the next line.

INTERFACE SOFTWARE

The printer program utilizes a data buffer that is maintained in RAM (figure 5). This buffer is filled by any appropriate input device (keyboard, tape, or other), and the program is then executed starting at address 0000 to print a line consisting of 16 characters. As shown in figure 4, the 16 columns — each column corresponding to a print wheel — are divided into two column words: COLWORD 1 representing the characters to be printed for columns D1 through D9 (D3 is blank), and COLWORD 2 representing characters for the remaining columns (D10 through D16). The character codes for each column and the constants used to select a particular column are stored in ROM. When the characters stored in the data buffer for a particular column agree with those in the character code list, the print wheel for that column is mechanically latched; thus, at the end of the timing cycle ($T_0 \ldots T_{11}$), all 16 print wheels are locked in position and the line is printed.

COLUMNS →	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1
CHARACTER →	9	8	7	6	5	4	3	2	1	0	.	6	6	--	*	M
	COLWORD 2							COLWORD 1								
BITS	6	5	4	3	2	1	0	7	6	5	4	3	2		1	0
TIMING SIGNAL																
T_0 →	1	1	1	1	1	1	1	1	1	0	1	1	1	--	0	1
T_1 →	1	1	1	1	1	1	1	1	0	1	1	1	1	--	1	1
T_2 →	1	1	1	1	1	1	1	0	1	1	1	1	1	--	1	1
T_3 →	1	1	1	1	1	1	0	1	1	1	1	1	1	--	1	1
T_4 →	1	1	1	1	1	0	1	1	1	1	1	1	1	--	1	1
T_5 →	1	1	1	1	0	1	1	1	1	1	1	1	1	--	1	1
T_6 →	1	1	1	0	1	1	1	1	1	1	1	0	0	--	1	1
T_7 →	1	1	0	1	1	1	1	1	1	1	1	1	1	--	1	1
T_8 →	1	0	1	1	1	1	1	1	1	1	1	1	1	-	1	1
T_9 →	0	1	1	1	1	1	1	1	1	1	1	1	1	--	1	1
T_{10} →	1	1	1	1	1	1	1	1	1	1	0	1	1	--	1	1
T_{11} →	1	1	1	1	1	1	1	1	1	1	1	1	1	--	1	0

Figure 4. When the print wheels are turning, a zero level sent to a wheel's control line will latch it. This figure shows the twelve pairs of COLWORDs that are sent to the printer interface during a print cycle.



*REMAINING RAM LOCATIONS ARE UNUSED.

Figure 5. Memory Allocation for Seiko Interface.

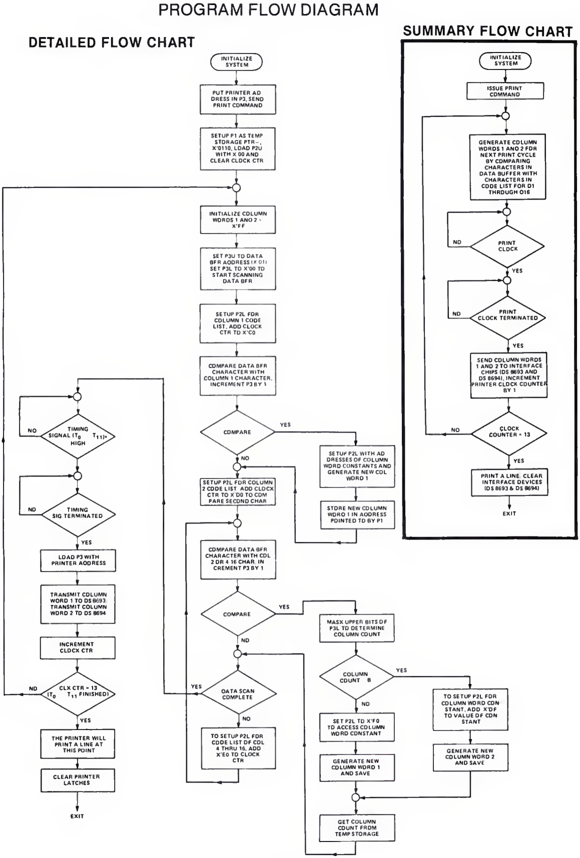


Figure 6. Seiko Printer Interface Firmware Flowcharts.

PROGRAM ASSEMBLY LISTING

```
                      TITLE   SCMP, 'SEIKO PRINTER PRGM'
     0001 P1          =       1
     0002 P2          =       2
     0003 P3          =       3
     0001 CLK1        =       1
     0002 CLK2        =       2
     0003 CLK3        =       3
     0004 PRINT       =       4
     0200 SEIKO       =       0200
     0001 TEMP1       =       1
     0002 TEMP2       =       2
     0004 CLKCTR      =       4
     0005 COLWR1      =       5
     0006 COLWR2      =       6
0000 08               NOP
0001 C400 PPNT        LDI     L(SEIKO)        ,SET UP POINTER ADPS
0003 33               XPAL    P3
0004 C402             LDI     H(SEIKD)
0006 37               XPAH    P3
0007 CB04             ST      PRINT(P3)       ,STAPT PPINTEP
0009 C401             LDI     1               ,SET UP HIGHEP MEMORY
000B 35               XPAH    P1
000C C400             LDI     0
000E 36               XPAH    P2
000F C410             LDI     010
0011 31               XPAL    P1              ,SET UP TEMP  STOPAGE
0012 C400             LDI     0
0014 C904             ST      CLKCTR(P1)      ,CLR CLY COUNTER
0016 C4FF CONTPRT     LDI     0FF
0010 C905             ST      COLWR1(P1)      ,CLR COL WOPD1
001A C906             ST      COLWP2(P1)      ,CLR COL WORD2
001C C401             LDI     1               ,SET UP DATA BFR ADRS
001E 37               XPAH    P3
001F C400             LDI     0
0021 33               XPAL    P3
0022 C104             LD      CLKCTR(P1)      ,SET UP POINTER FOR
0024 F4C0             ADI     0C0             ,COL1 CODE LIST
0026 32               XPAL    P2
0B27 C701             LD      @1(P3)          ,BEGIN SCAN FOR DATA
0029 E200             XOR     (P2)
002B 9827             JZ      COMPR1
002D C104 PETCOMP     LD      CLKCTR(P1)      ,SET UP POINTER FOR C
0B2F F4DB             ADI     0D0             ,SELECT COL2 CODE LIS
0031 32               XPAL    P2
0032 C701             LD      @1(P3)          ,NO PPINTING IN COL3
0034 E200 CONTSCN     XOR     (P2)            ,CHECK IF DATA=CODE L
0036 9827             JZ      COMPR2
003B 33               XPAL    P3
0039 C901             ST      TEMP1(P1)
003B D40F             ANI     0F              ;MASK UPPEP 4 BITS OF
003D E40F SCNCHK      XRI     0F              ;CHECK IF SCANNING CO
003F 900C             JZ      TEST            ; JMP TO WAIT FOR PRTR
0041 C101             LD      TEMP1(P1)       ,LD DATA BFR ADRS.
0043 33               XPAL    P3
0044 C104             LD      CLKCTR(P1)
0046 F4E0             ADI     0E0             ;LD COL4 TO 16 CODE A
0040 32               XPAL    P2
0049 C701             LD      @1(P3)
004B 90E7             JMP     CONTSCN
004D 06   TEST        CSA
004E D41B             ANI     010
0050 98FB             JZ      TEST
0052 9033             JMP     FNSHSCN
0054 C4F0 CDMPR1      LDI     0F0             ,LD COL WORD CONST  A
0056 32               XPAL    P2
0057 C200             LD      (P2)            ;CDLWORD CONST TD ACU
0059 D105             AND     CDLWR1(P1)      ,DENERATE COLWRD 1
005B C905             ST      CDLWR1(P1)      ,SAVE NEW CDLWRD1
005D 90CE             JMP     RETCDMP
005F 33   CDMPR2:     XPAL    P3
0060 C901             ST      TEMP1(P1)       ;SAVE DATA BFR ADRS
0062 D40F             ANI     0F              ;MASK UPPER 0ITS
0064 C902             ST      TEMP2(P1)       ,SAVE COLMN CDUNT
0066 F4F7             ADI     -9
0060 940F             JP      GENCDL2         ;CDL CDUNT>B
006A C102             LD      TEMP2(P1)       ,DET CDL CDUNT
006C F4F0             ADI     0F0             ,ADD ADRS FOR COLWRD
006E 32               XPAL    P2
006F C2FF             LD      -1(P2)          ;COLWRD CONST TD ACU
0071 D105             AND     CDLWR1(P1)      ;GENERATE CDLWRD1
0073 C905             ST      CDLWR1(P1)      ;SAVE NEW CDLWRD1
0075 C102 COL2RET.    LD      TEMP2(P1)       ,LD CDLMN COUNT
0077 90C4             JMP     SCNCHK          ,GD TD SCAN CDMPLT CH
0079 C102 GENCOL2     LD      TEMP2(P1)       ,GET COL COUNT
0070 02               CCL
007C F4F0             ADI     0F0             ,ADD ADRS FOR COLWRD
007E 32               XPAL    P2
007F C2FF             LD      -1(P2)          ;CDLWRD CONST TO ACU
0001 D106             AND     CDLWR2(P1)      ;GENERATE CDLWRD2
0083 C906             ST      COLWR2(P1)      ;SAVE NEW CDLWRD2
0085 90EE             JMP     CDL2RET
0007 06   FNSHSCN     CSA                     ;XFR SENSEA TD ACU
0008 D410             ANI     010             ;CHECK IF SENSE A PRE
008A 9CF0             JNZ     FNSHSCN         ;LDDP 0ACK TD FINISH
008C C400             LDI     L(SEIKD)        ;DET SEIKD ADRS
000E 33               XPAL    P3
000F C402             LDI     H(SEIKD)
0091 37               XPAH    P3
0092 C105             LD      COLWR1(P1)      ;GET CDLWRD1
0094 C002             ST      CLK2(P3)        ,XFR COLWRD1 TD PRINT
0096 C106             LD      COLWR2(P1)      ;GET CDLWRD2
0098 CB01             ST      CLK1(P3)        ;XFR COLWRD2 TO PRINT
009A A904             ILD     CLKCTR(P1)      ,INCREMENT CLK COUNTE
009C E40D             XRI     13              ,CHECK CLK CTR = 13
009E 9000             JZ      DONE
00A0 C400             LDI     0
00A2 37               XPAH    P3
00A3 C415             LDI     015
00A5 33               XPAL    P3
00A6 93FF             JMP     (P3)
00A8 C4FF DONE        LDI     0FF
00AA CB03             ST      CLK3(P3)        ;CLR PRTP LATCHES
          EXIT                                ,USER RETURN ROUTINE
     00C0              =0C0
00C0 43   COL1         BYTE   'C','I','1','U','5','6','A','M'
00C1 49
00C2 31
00C3 55
00C4 35
00C5 36
00C6 41
00C7 4D
00C0 4B                BYTE   'K','E','P','N'
00C9 45
00CA 50
00CB 4E
     00D0              =0D0
00D0 2A   COL2         BYTE   '*','#','+','-','%','=','6','7'
00D1 23
00D2 2B
00D3 2D
00D4 25
00D5 3D
00D6 36
00D7 37
00D0 53                BYTE   'S','T',':','X'
00D9 54
00DA 3A
00DB 50
     00E0              =0E0
00E0 30   COL4         BYTE   '0','1','2','3','4','5','6','7'
00E1 31
00E2 32
00E3 33
00E4 34
00E5 35
00E6 36
00E7 37
00E3 30                0YTE   '0','9',' ','-'
00E9 39
00EA 2E
00E0 2D
     00F0              =0F0
00F0 FE   CDNST        BYTE   0FE,0FD,0FB,0F7,0EF,0DF,00F,07F
00F1 FD
00F2 FB
00F3 F7
00F4 EF
00F5 DF
00F6 0F
00F7 7F
00F8 FE                0YTE   0FE,0FD,0F0,0F7,0EF,0DF,00F,07F
00F9 FD
00FA FB
00FB F7
00FC EF
00FD DF
00FE 0F
00FF 7F
     0001              END    PRNT


CLK1    0001         CLK2    0002           CLK3    0003
CLKCTR  0004         CDL1    00C0 *         COL2    00D0 *
COL2RE  0075         CDL4    00E0 *         CDLWR1  0005
CDLWR2  0006         CDMPR1  0054           CDMPR2  005F
CONST   00F0 *       CDNTPR  0016 *         CDNTSC  0034
DONE    00A0         EXIT    00AC *         FNSHSC  0007
GENCOL  0079         P1      0001           P2      0002
P3      0003         PRINT   0004           PRNT    0001
RETCDM  002D         SCNCHK  003D           SEIKD   0200
TEMP1   0001         TEMP2   0002           TEST    004D


ND ERRDR LINES
SDURCE CHECKSUM=4F5D
 D0JECT CHECKSUM= 0600

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74LS02	.28	74LS37	.33	74LS93	.57	74LS160	1.02	74LS253	.84
74LS03	.28	74LS38	.33	74LS107	.39	74LS161	1.02	74LS257	.75
74LS04	.29	74LS40	.28	74LS109	.39	74LS162	1.02	74LS258	.75
74LS05	.29	74LS42	.67	74LS112	.39	74LS163	1.02	74LS266	.39
74LS08	.29	74LS47	.79	74LS113	.39	74LS164	1.02	74LS283	.79
74LS09	.29	74LS48	.77	74LS114	.39	74LS168	1.14	74LS290	.65
74LS10	.28	74LS51	.28	74LS125	.49	74LS169	1.14	74LS293	.65
74LS11	.28	74LS54	.28	74LS126	.49	74LS170	1.73	74LS365	.67
74LS12	.28	75LS55	.28	74LS132	.81	74LS173	1.34	74LS366	.67
74LS13	.47	74LS73	.39	74LS136	.39	74LS174	1.06	74LS367	.67
74LS14	1.02	74LS74	.39	74LS138	.73	74LS175	.84	74LS368	.67
74LS15	.28	74LS75	.53	74LS139	.73	74LS190	1.18	74LS386	.39
74LS20	.28	74LS76	.39	74LS151	.75	74LS191	1.18	74LS670	2.34
74LS21	.28	74LS78	.39	74LS153	.75	74LS196	.86	71LS95	.77
74LS22	.28	74LS83	.79	74LS154	1.10	74LS197	.86	71LS96	.77
74LS26	.33	74LS86	.39	74LS155	.75	74LS247	.79	71LS97	.77
74LS27	.33			74LS156	.75			71LS98	.77

INTEGRATED CIRCUITS — TTL, CMOS, LINEAR & MOS

7400	.21	7476	.32	74181	2.15	4012	.23	4520	1.14
7401	.21	7480	.70	74182	.79	4013	.40	4527	1.68
7402	.21	7482	.70	74184	2.19	4014	.96	4528	.88
7403	.21	7483	.70	74185	2.19	4015	.96	4585	1.23
7404	.21	7485	.89	74188	3.50	4016	.40	2102-1	1.99
7405	.21	7486	.28	74189	3.50	4017	1.05	8080A	24.95
7406	.25	7489	2.19	74190	1.23	4018	1.05	CA3046	.75
7407	.25	7490	.44	74191	1.23	4019	.23	LM2111N	1.25
7408	.21	7491	.70	74192	.88	4020	1.14	LM309K	1.80
7409	.21	7492	.44	74193	.88	4021	1.14	LM324A	1.28
7410	.21	7493	.44	74194	.88	4022	.96	LM340T-5	1.25
7411	.21	7494	.70	74195	.88	4023	.23	LM340T-6	1.25
7412	.21	7495	.70	74196	.88	4024	.84	LM340T-8	1.25
7413	.25	7496	.70	74197	.88	4025	.23	LM340T-12	1.25
7414	.89	74100	1.28	74198	1.49	4026	1.68	LM340T-15	1.25
7416	.25	74107	.30	74199	1.49	4027	.40	LM340T-18	1.25
7417	.25	74109	.33	74251	1.09	4028	.89	LM340T-24	1.25
7420	.21	74121	.35	74279	.55	4029	1.14	LM3900N	.88
7421	.25	74122	.44	74365	.67	4030	.23	LM3909N	.69
7423	.35	74123	.61	74366	.67	4033	1.51	MC1456V	1.00
7425	.35	74125	.40	74367	.67	4034	3.50	MC1458V	.53
7426	.25	74126	.40	74368	.67	4035	1.14	MC3302P	1.15
7427	.33	74132	.70	8093	.40	4040	1.14	NE536T	3.24
7428	.28	74141	.88	8094	.40	4041	.79	NE540L	2.04
7430	.21	74145	.70	9095	.67	4042	.79	NLS55V	.48
7432	.25	74147	1.63	8096	.67	4043	.70	NE556A	.88
7433	.30	74148	1.30	8097	.67	4044	.70	NE5608	3.83
7437	.25	74150	1.16	8098	.67	4046	1.86	NE5618	3.83
7438	.25	74151	.70	75150	1.16	4049	.40	NE5628	3.83
7440	.21	74153	.65	75450	.88	4050	.40	NE565A	1.25
7442	.53	74154	1.03	75451	.61	4051	1.26	NE566V	1.28
7443	.63	74155	.70	75452	.61	4052	1.26	NE567V	1.36
7445	.70	74156	.70	75453	.61	4053	1.26	uA709CV	.44
7446	.70	74157	.70	75454	.61	4060	1.58	uA710CA	.44
7447	.70	74160	.88	75491	.81	4066	.79	uA711CA	.53
7448	.70	74161	.88	75492	.84	4071	.23	uA723CA	.60
7450	.21	74162	.88	75493	1.09	4072	.23	uA733CA	.75
7451	.21	74163	.88	75494	1.19	4073	.23	uA741CV	.44
7453	.21	74164	.96	82525	2.19	4075	.23	uA747CA	.70
7454	.21	74165	1.15	4000	.23	4081	.23	uA748CV	.49
7459	.21	74166	1.26	4001	.23	4082	.23	uA7805CU	1.25
7460	.21	74170	2.64	4002	.23	4502	.79	uA7806CU	1.25
7470	.30	74173	1.42	4006	1.23	4510	1.14	uA7808CU	1.25
7472	.30	74174	.98	4007	.23	4511	1.05	uA7812CU	1.25
7473	.30	74175	.93	4008	.79	4514	2.80	uA7815CU	1.25
7474	.30	74176	.79	4009	.44	4515	2.80	uA7818CU	1.25
7475	.49	74177	.79	4010	.44	4516	1.23	uA7824CU	1.25
		74180	.70	4011	.23	4518	1.14		

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1N4005	.82/10	7.05/C	$63/M
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1N5227B	3.6v	.15	$11/C	1N5237B	8.2v	.15	$11/C
1N5228B	3.9v	.15	$11/C	1N5238B	8.7v	.15	$11/C
1N5229B	4.3v	.15	$11/C	1N5239B	9.1v	.15	$11/C
1N5230B	4.7v	.15	$11/C	1N5240B	10v	.15	$11/C
1N5231B	5.1v	.15	$11/C	1N5241B	11v	.15	$11/C
1N5232B	5.6v	.15	$11/C	1N5242B	12v	.15	$11/C
1N5233B	6.0v	.15	$11/C	1N5243B	13v	.15	$11/C
1N5234B	6.2v	.15	$11/C	1N5244B	14v	.15	$11/C
1N5235V	6.8v	.15	$11/C	1N5245B	15v	.15	$11/C

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- NSN584 0.5" CA . $2.60/Pair
- NSN783 0.7" CC . $3.00/Pair
- NSN784 0.7" CA . $3.00/Pair

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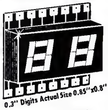

0.3" Digits Actual Size 0.85"x0.8"

0.7" Digits Actual Size 1.25"x1.2"

0.5" Digits Actual Size 1.05"x1.0"

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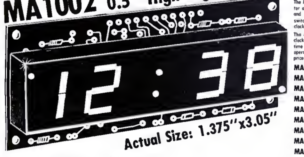

Actual Size: 1.375"x3.05"

MA1002A 12 Hour AM-PM	$10.50
MA1002C 24 Hour	$10.50
SPECIAL TRANSFORMER & SWITCHES	$3.45

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The MA1003 clock module is a fully assembled and tested 12 hour clock using a high brilliance green flourescent display and crystal time base making it perfect for car, boat or other portable use. It operates directly from 12 volts DC so no transformer is needed. Our price includes three push button switches for setting the time.

MA1002A	.5" LED 12 Hour AM-PM Clock Module	$10.50
MA1002A SET	Module with Transformer & Switches	$13.95
MA1002C	.5" LED 24 Hour Clock Module	$10.50
MA1002C SET	Module with Transformer & Switches	$13.95
MA1003	12 Volt Car Clock with Switches	$24.95
MA1010A	.84" LED 12 Hour AM-PM Clock Module	$13.00
MA1010A SET	Module with Transformer & Switches	$16.45
MA1010C	.84" LED 24 Hour Clock Module	$13.00
MA1010C SET	Module with Transformer & Switches	$16.45

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.47/50V	.08	.65/10	22/50V	.12	1.00/10	330/25V	.23	1.86/10
1/50V	.08	.65/10	100/6.3V	.09	.75/10	470/10R	.21	1.71/10
2.2/50V	.08	.65/10	100/10V	.10	.77/10	470/16V	.23	1.81/10
3.3/50V	.08	.65/10	100/16V	.11	.85/10	470/25V	.29	2.35/10
4.7/35V	.08	.65/10	100/25V	.13	1.10/10	1000/10V	.24	1.96/10
4.7/50V	.08	.68/10	100/50V	.21	1.71/10	1000/16V	.29	2.35/10
10/16V	.08	.65/10	220/10V	.13	1.08/10	1000/25V	.42	3.33/10
10/25V	.08	.65/10	220/16V	.15	1.16/10	2200/10V	.42	3.33/10
10/50V	.10	.75/10	220/25V	.21	1.71/10	2200/16V	.54	4.30/10
22/16V	.08	.67/10	220/50V	.29	2.35/10	2200/25V	.58	4.67/10
22/25V	.09	.70/10	330/10V	.15	1.16/10	3300/16V	.89	7.14/10
			330/16V	.21	1.66/10			

AXIAL ELECTROLYTICS

.47/10V	.11	.90/10	33/25V	.14	1.15/10	330/16V	.29	2.35/10
1/30V	.11	.90/10	33/50V	.19	1.52/10	330/25V	.32	2.54/10
3.3/35V	.12	.95/10	47/16V	.14	1.15/10	470/16V	.32	2.55/10
3.3/50V	.12	1.00/10	47/25V	.17	1.30/10	470/25V	.37	3.00/10
4.7/25V	.11	.90/10	47/50V	.21	1.17/10	1000/10V	.33	2.65/10
4.7/35V	.12	.95/10	100/10V	.14	1.13/10	1000/16V	.39	3.15/10
4.7/50V	.12	1.00/10	100/16V	.17	1.30/10	1000/25V	.56	4.50/10
10/25V	.12	1.00/10	100/25V	.20	1.55/10	2200/10V	.50	3.96/10
10/50V	.14	1.15/10	100/50V	.29	2.30/10	2200/16V	.62	4.95/10
22/16V	.12	1.00/10	220/10V	.18	1.42/10	2200/25V	.79	6.36/10
22/25V	.13	1.05/10	220/16V	.20	1.55/10	3300/16V	.95	7.63/10
22/50V	.17	1.32/10	220/25V	.29	2.35/10	4700/16V	1.09	8.70/10
33/16V	.12	1.00/10	220/50V	.40	3.23/10	10000/10V	1.15	9.19/10
			330/10V	.14	1.16/10			

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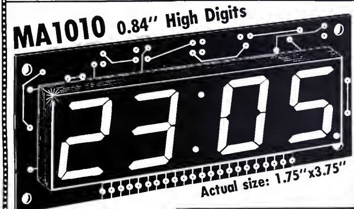

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.0047 uf	.40/10	3.50/C
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CHECKBOOK BALANCER PROGRAM — JHCBBP

by Jim Huffman

INTRODUCTION

Here's another one of those practical applications of the computer that should tend to help you to be able to justify to your spouse why you've got a couple thousand dollars tucked away in the basement. This particular program uses a balance from your checking account statement, subtracts service charges, and calculates checkbook balance from the outstanding checks and deposits you enter. These would be the checks and deposits not shown on your statement. The program also uses an adding machine entry format—that is, you do not add the decimal point. One hundred dollars would be represented as 10000. The computer then divides it by 100 to provide the display of 100.00.

PROGRAM CONFIGURATION

While this program should run easily in anyone's BASIC, there may be some modifications to the control statements. One: DIGITS = 2 is valid for SWTPC 6800 8K Basic, but may not be valid for your BASIC. Also, STEP 9 has a control function that causes home-up and erase the screen on my CT1024 terminal. Your terminal may be different. In fact, if you have a scrolling terminal, you may decide to put in 16 line feeds or whatever in order to clear the screen.

RUNNING PROGRAM

The program listing is self-explanatory. One of its nicer features is that after receiving what the balance should be and how many checks have been written, you may re-enter more checks or deposits that you may have stumbled on in going over your checkbook without restarting the program and losing all the data that you already had in. You will automatically get the number of checks and number of deposits, the total of the checks and deposits, and the final balance. Again, note step 185; the home-up and erase function is used again before the data is displayed so that it will be displayed on a clean screen.

PROGRAM EXAMPLES

```
#RUN
BALANCE FROM STATEMENT?10000
SERVICE CHARGES?500

    ENTER AMOUNT (NO DECIMALS) OF ITEMS NOT
    ON STATEMENT

CHECKS FIRST
ENTER 0 TO TERMINATE
ENTER?597
ENTRY?475
ENTRY?12345
ENTRY?0
NOW DEPOSITS—ENTER 0 TO TERMINATE
ENTRY?20000
ENTRY?0


FINAL BALANCE SHOULD BE $160.83

FROM STATEMENT: BAL 100 LESS SURCHARGE 5 = 95
TOTAL CHECKS = 3 for $134.17
TOTAL DEPOS = 1 FOR $200

MORE ENTRIES (Y OR N)?Y

    ENTER AMOUNT (NO DECIMALS) OF ITEMS NOT
    ON STATEMENT

CHECKS FIRST
ENTER 0 TO TERMINATE
ENTRY?395
ENTRY?0

NOW DEPOSITS—ENTER 0 TO TERMINATE
ENTRY?0


FINAL BALANCE SHOULD BE $156.88

FROM STATEMENT: BAL 100 LESS SURCHARGE 5 = 95
TOTAL CHECKS = 4 FOR $138.12
TOTAL DEPOS = 1 FOR $200

MORE ENTRIES? (Y OR N)?N
```

PROGRAM BASIC LISTING

```
0000 REM CHECKBOOK BALANCER
0001 REM PROGRAMMED BY J. HUFFMAN
0002 REM 01-05-77
0003 REM MICROCOMPUTER: SWTP 6800
0004 REM SUPPORT SOFTWARE: 8K BASIC
0009 PRINT " "
0010 INPUT "BALANCE FROM STATEMENT",B
0020 INPUT "SERVICE CHARGES",S
0030 PRINT TAB(4);"ENTER AMOUNT (NO DECIMALS) OF ITEMS NOT ON STATEMENT"
0040 PRINT
0045 PRINT "CHECKS FIRST"
0050 PRINT "ENTER 0 TO TERMINATE"
0060 INPUT "ENTRY",F
0065 IF F=0 THEN 110
0070 LET N=N+1
0090 LET T=T+F
0100 GOTO 60
0110 PRINT
0115 PRINT "NOW DEPOSITS---ENTER 0 TO TERMINATE"
0120 INPUT "ENTRY",F
0125 IF F=0 THEN 170
0130 LET M=M+1
0150 LET D=D+F
0160 GOTO 120
0170 REM ****OUTPUTS DATA
0180 REM ***M=NO DEP, D=DEP TOT, N=NO CHKS, T=CHKS TOT
0185 PRINT " "
0190 PRINT "FINAL BALANCE SHOULD BE $";((B+D)-(T+S))/100
0200 PRINT
0205 PRINT "FROM STATEMENT: BAL ";B/100;
0206 PRINT " LESS SURCH ";S/100;"=";(B-S)/100
0210 PRINT "TOTAL CHECKS = ";N;" FOR $";T/100
0220 PRINT "TOTAL DEPOS = 2;M;" FOR $";D/100
0230 PRINT
0240 INPUT "MORE ENTRIES (Y OR N)",A$
0250 IF A$="2Y" THEN 280
0260 PRINT "THANKS, SEE YA NEXT MONTH"
0270 END
0280 PRINT " "
0290 GOTO 30
```

MICROCOMPUTER

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2101	256 x 4 Bit	1 us	TS		3.00
2102	1024 x 1 Bit	1 us	TS		1.50
2102-1	1024 x 1 Bit	500 ns	TS		1.75
2111A-4	256 x 4 Bit	450 ns	TS	(18 pin)	4.15
2112A 4	256 x 4 Bit	450 ns	TS	(16 pin)	2.45
2501B	256 x 1 Bit	1 us			1.45
5101	256 x 4 Bit	80 ns	OC		2.95
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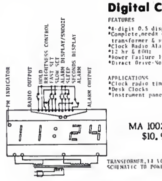

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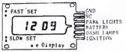

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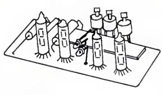

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I C SOCKETS

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22	Lo Pro Open Frame Tin	.50
22	Wire Wrap Tin	.95
24	Standard P C Tin	.50
24	Wire Wrap Tin	.85
28	Lo Pro (Open Frame) Tin	.40
28	Standard P C Tin	.60
28	Wire Wrap Tin	.95
40	Lo Pro (Open Frame) Tin	.50
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LOGAN . . .
A Logic Circuit Analysis Program

by Robert J. Bishop

INTRODUCTION

I think that I should preface this article by saying that I am not at all a "hardware type"; I have almost no experience in designing or constructing logic circuits. But the subject of logic gates is very fascinating. So one day I decided that it would be kind of fun to write a simple BASIC program for analyzing networks of logic gates. As a result, program LOGAN (LOGic ANalysis) was created.

GATES AND STATES

For the purposes of LOGAN, a *gate* is defined as a device which produces a single logical output *state* as a function of one or more logical input *states*. A binary logic *state* is a value of either 0 or 1, but I also allow for two more values: undefined and $\overline{\text{undefined}}$. For brevity, I will sometimes use the symbol ? to represent undefined; correspondingly, the symbol $\overline{?}$ will represent $\overline{\text{undefined}}$. Now, it might be argued that a state can't be "undefined"; either it's a 1, or it isn't. While this may be true in any actual real world circuit, I still maintain that it is important to distinguish between those states that are actually *determined* vs those that just happen to turn on *randomly*. Thus, when LOGAN says that a state is a 1 (or a 0), it means that the logical state is definite and that the corresponding real world circuit will always have that uniquely same logical 1 (or 0) value.

If we allow for an undefined state, it soon becomes evident that we must also allow for the complementary state, $\overline{\text{undefined}}$. For example, if the input to an inverter is undefined, what comes out? Is it also undefined? Well . . . yes, but in the opposite sense. Even though we may not know if the state is a 0 or a 1 we do know that it is the complement of whatever went in. Hence, if the input and output states were to be ORed together, the result would be a determined 1, even though the two ORed states were, in a sense, "undefined".

Figure 1 shows a set of Truth Tables for AND, OR, and exclusive OR (XOR) gates with two inputs. The complementary gates, NAND, NOR, and XNOR, are simply the complements of the tabular values in Figure 1.

HOW TO USE LOGAN

The circuit to be investigated is specified as a network of gates and nodes (or lines). Each gate must have one, and only one, output node and from one to six input nodes. The only gates the program will recognize are: AND, OR, NAND, NOR, INV (inverter), XOR (exclusive OR), and XNOR (exclusive NOR).

Each node can exist in one of four states: 0, 1, ?, or $\overline{?}$. Any node not explicitly declared to be in either state 0 or state 1 will assume the default value of ?.

The program can handle up to 63 gates and up to 255 nodes. Each gate must be labeled with an integer number from 1 to 63, and each node must be labeled with an integer from 1 to 255. The order in which labels are assigned is immaterial, but each gate (or node) must be *uniquely* numbered in order to avoid ambiguity. Thus, although two different gates (or nodes) cannot both use the same numerical value as a label, a node and a gate can both use the same number as a label without confusion.

The program is modularly designed to perform any one of five tasks:

Task	Function
-2	Input the logic circuit.
-1	Input the defined states of nodes.
0	Analyze the circuit.
1	Output the defined states of nodes.
2	Output the logic circuit.

Notice the symmetry of the task numbers. A value of TWO refers to *specification of the circuit*. A NEGATIVE means that you specify *to the computer*; a positive means that the computer specifies *to you*. Similarly, a value of ONE refers

AND

	0	1	?	$\overline{?}$
0	0	0	0	0
1	0	1	?	$\overline{?}$
?	0	?	?	0
$\overline{?}$	0	$\overline{?}$	0	$\overline{?}$

OR

	0	1	?	$\overline{?}$
0	0	1	?	$\overline{?}$
1	1	1	1	1
?	?	1	?	1
$\overline{?}$	$\overline{?}$	1	1	$\overline{?}$

XOR

	0	1	?	$\overline{?}$
0	0	1	?	$\overline{?}$
1	1	0	$\overline{?}$	?
?	?	$\overline{?}$	0	1
$\overline{?}$	$\overline{?}$	?	1	0

Figure 1.

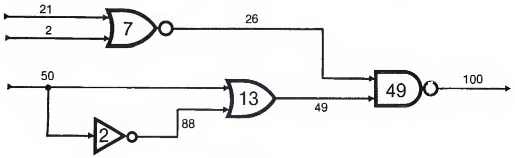


Figure 2.

to the specification of node states; the sign, again, indicates the *direction* of the specification.

Perhaps the easiest way to show how to use LOGAN is by working through a specific example. Figure 2 shows a simple logic circuit consisting of four gates and seven nodes. Suppose we are interested in the states of all nodes when node 21 is in state 1 and node 2 is in state 0.

Figure 3. Logic Analysis Program

```
TASK ?-2
OLD OR NEW ?NEW


LABEL ?13
GATE ?OR
NODE ?49

NODE ?88

NODE ?50
NODE ?0

LABEL ?7
GATE ?NOR

NODE ?26

NODE ?21

NODE ?2
NODE ?0

LABEL ?2

GATE ?INV
NODE ?88

NODE ?50
NODE ?0


LABEL ?49

GATE ?NAND

NODE ?100

NODE ?26
NODE ?49
NODE ?0


LABEL ?0
```

```
TASK ?-1

CLEAR ?YES

NODE ?21
STATE ?1

NODE ?2

STATE ?0

NODE ?0


TASK ?0
ITERATION 1
ITERATION 2


TASK ?1

2 0    21 1   26 0   49 1   100 1


TASK ?2
2  INV   88  50
7  NOR   26  21  2
13 OR    49  88  50
49 NAND  100 26  49


TASK ?3

>
```

Figure 3 is a printout of LOGAN's run of the circuit shown in Figure 2. After identifying itself, the program asks for a task number. Since we wish to specify the circuit to the computer, we type: -2. The computer then asks us if the circuit we wish to specify is a NEW one, or do we wish to simply modify the OLD one currently in its memory. Since there isn't any OLD circuit at this point, we respond with: NEW. After a slight pause the computer is ready to accept our circuit. It first asks for the numerical label of the gate. Since the order of specification is arbitrary, let's give it gate #13 first. Next, it asks for the node labels associated with the gate. The first node specified must be the output node of the gate. Thus we respond with: 49. It again asks for a node, but this time an INPUT node. Since the order of indication is immaterial, we respond with: 88, and then: 50. It now asks for yet another input node (Remember, a gate can have as many as six inputs), but there are no more. So we terminate the queries by typing a zero. The program now advances to the next gate and asks for its label. We respond appropriately, as above, until all gates have been specified, at which point a label number of zero terminates this phase of the program and another task number is requested.

We now want to assign values to nodes 2 and 21, so we invoke task -1. The computer asks us if it should clear—set to undefined—all nodes. We reply: YES. It then asks for the label of a node whose state is to be specified. (Again, the order of specification is unimportant.) We type: 21, and then set its state to 1. Similarly, we specify the state of node 2 to be 0. Again, a label of zero terminates this phase, and the computer returns to the task requesting phase.

Our circuit is now in the memory and we are ready to "turn the computer loose" on it. So we invoke task 0, the heart of the program. After a couple of iterations the analysis is finished and control is again returned to the task requester.

To see the results of the analysis we ask the computer to display the states of all nodes whose states are currently DEFINED: we invoke task 1. It shows us that nodes 2 and 26 are both in state 0, while nodes 21, 49, and 100 are all in state 1. (Notice that the states of nodes 50 and 88 are not indicated, as these are not defined.)

For completeness, we can now tell the computer to show us the circuit currently in its memory. This, which is done by invoking task 2, serves as a way of checking that the circuit in memory is actually the one we intend to be there.

At this point, we could now change some of the input nodes' states and rerun the analysis. Or we might want to modify the circuit slightly first. For example, suppose we wanted to change gate 7 from a NOR to an AND gate. We would invoke task -2 and specify: OLD. We would then indicate that label 7 should be an AND gate, that its output node is number 26, and that its input nodes are 2 and 21. (Notice that *all* the parameters of a changed gate must be re-specified, even if some don't change.)

When we are completely finished with LOGAN, specifying a task of 3 terminates the program and returns to BASIC.

HOW THE PROGRAM WORKS

LOGAN is written in a modular fashion and consists of six separate sections, each of which is relatively independent of the others.

The first section, lines 10-70, merely initializes certain parameters and then requests the task number. The appropriate task is then invoked by the computed GOTO statement in line 70.

The next part of the program, lines 1000-1310, allows for specification of the logic circuit. If the circuit is NEW, the array containing the circuit information is cleared (set to zero) before accepting any new information. The array specifying the circuit, referenced by variable C in the program, is a 64 x 8 byte array located at decimal address 1024. Because of the length of the program and the limited amount of memory available on my Apple computer (8K bytes), I had to use the PEEK and POKE features of Apple BASIC. To examine the byte at decimal address A, you merely reference PEEK (A); to deposit a quantity Q into the byte at address A, you use the statement: POKE A,Q. On systems with more memory, the use of PEEK and POKE can be eliminated by using a DIM'd variable. The C array can be thought of as 64 rows of 8 columns each, where the row number corresponds to the gate label. The first of the eight columns indicates the *type* of the gate (AND, NOR, etc.), or a zero if no gate exists with that label. The second column points to the OUTPUT node in the node array N (see below). The third through eighth columns contain pointers to the INPUT nodes, with zeros serving as filler for those gates having less than six inputs.

The PEEK and POKE functions only treat memory as a linear (one dimensional) array. But the circuit array is a two dimensional array (64 x 8). So I linearize the array by computing any I,J subscript as 8∗I + J (where I ranges from 0 to 63 and J ranges from 0 to 7).

The third part of the program, lines 2000-2090, allows for specification of the initial node states. If the nodes are to be cleared first, they all get assigned the value 255 (undefined) before being reassigned. The array of node states (referenced by variable N) is a 256 byte array located at decimal address 768. Again, because of memory limitations, this array is accessed via PEEK and POKE STATEMENTS. The address of each byte in the node array corresponds to the node label. Each node can exist in one of four states: zero (0), one (1), undefined (255), or undefined (3).

Now we come to the "guts" of the program, lines 3000-3990. Here is where the actual circuit analysis takes place. The process is really quite simple and straightforward. A search is made through the circuit array for those labels which have a gate assigned to them. The states of the input nodes to the gate are examined and compared with the state of the output node. If the output node is currently in a state that is inconsistent with the inputs to the gate, the output node state is changed to the correct state and a flag is set indicating that an output node has changed state. At the end of the search the flag is tested. If no nodes have undergone a change of state, the analysis terminates with the stable node states in the node array. Otherwise, the entire search is repeated until stability is reached. If an oscillating type of circuit is presented to the program e.g., a NOR gate with its output node connected to one of its inputs, the program will never converge on a stable solution and it will iterate forever. So care must be used when analyzing logic circuits with feedback loops in them. (You can have them, but just make sure they're stable.)

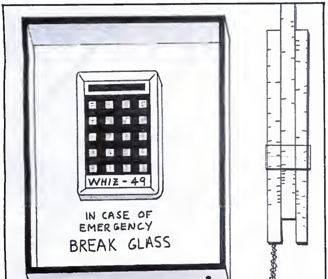
The final two parts of the program, lines 4000-4100 and lines 5000-5210, merely tabulate a display of the node array and circuit array, respectively.

The program, as listed here, uses most of the available memory of an 8K Apple-one computer. Consequently, the listing is not very heavily commented. But the program is simple enough so that there should be very little difficulty in understanding it.

LOGAN PROGRAM LISTING

```
   1 REM * LOGIC ANALYSIS PROGRAM *
   2 REM WRITTEN BY ROBERT J. BISHOP

  10 DIM A(8),A$(22),C$(4)
  20 A(1)=1:A(2)=4:A(3)=6:A(4)=
     9:A(5)=13:A(6)=16:A(7)=19:
     A(8)=23
  30 A$="ANDORINVNANDNORXORXNOR"

  40 N=768:C=1024
  45 PRINT : PRINT "LOGIC ANALYSIS P
     ROGRAM"
  50 PRINT : PRINT : INPUT "TASK: "
     ,P
  60 IF ABS (P)>3 THEN 50
  70 GOTO 1000*(P+3)
 100 REM  INPUT THE CIRCUIT
1000 INPUT "OLD OR NEW: ",C$
1010 IF C$="OLD" THEN 1040
1020 IF C$#"NEW" THEN 1000
1030 FOR K=8 TO 511: POKE C+K,0
     : NEXT K
1040 PRINT : INPUT "LABEL: ",L
1050 IF L>63 THEN 1040
1060 IF L<1 THEN 50
1070 L=8*L
1080 FOR K=0 TO 7: POKE C+L+K,0
     : NEXT K
1100 INPUT "GATE: ",C$
1110 IF C$="DEL" THEN 1040
1200 G=0
1210 FOR K=1 TO 7
1220 IF C$=A$(A(K),A(K+1)-1) THEN
     G=K
1230 NEXT K
1240 IF G=0 THEN 1100
1250 POKE C+L,G:L=L+1
1300 INPUT "NODE: ",G
1310 IF G THEN 1250: GOTO 1040
1500 REM  INPUT THE NODE STATES
2000 INPUT "CLEAR ",C$
2010 IF C$="NO" THEN 2050
2020 IF C$#"YES" THEN 2000
2030 FOR K=1 TO 255: POKE N+K,255
     : NEXT K
2050 PRINT : INPUT "NODE: ",G
2060 IF G<1 THEN 50
2070 IF G>255 THEN 2050
2000 INPUT "STATE: ",S
2090 POKE N+G,S: GOTO 2050
2500 REM  ANALYZE THE CIRCUIT
3000 I=0
3010 I=I+1: PRINT "ITERATION ";
     I
3020 T=0
3030 FOR K=1 TO 63
3040 G= PEEK (C+8*K)
3050 IF G=0 THEN 3500
3060 GOTO 3050+50*G
3100 Z=0: GOSUB 3900: GOTO 3450

3150 Z=1: GOSUB 3900: GOTO 3450

3200 O= PEEK (N+ PEEK (C+8*K+2)
     )
3210 GOSUB 3600: GOTO 3450
3250 Z=0: GOSUB 3900: GOSUB 3600
     : GOTO 3450
3300 Z=1: GOSUB 3900: GOSUB 3600
     : GOTO 3450
3350 GOSUB 3700: GOTO 3450
3400 GOSUB 3700: GOSUB 3600
3450 IF O= PEEK (N+ PEEK (C+8*K+
     1)) THEN 3500
3460 T=1: POKE N+ PEEK (C+8*K+1
     ),O
```

```
3500 NEXT K
3550 IF T THEN 3010:  GOTO 50
3575 REM  INVERTER
3600 IF O>1 THEN 3610:O=1-O:  RETURN

3610 O=257-O:  RETURN
3650 REM  EXCLUSIVE OR
3700 Q1= PEEK (N+ PEEK (C+8*K+2
     ))
3710 Q2= PEEK (N+ PEEK (C+8*K+3
     ))
3720 IF Q1 AND Q2 THEN 3740
3730 O=Q1+Q2:  RETURN
3740 IF Q1-1 AND Q2-1 THEN 3760

3750 O=Q1*Q2:  GOSUB 3600:  RETURN

3760 O=1:  IF Q1=Q2 THEN O=0:  RETURN

3800 REM  AND & OR
3900 O=1-Z:  FOR J=2 TO 7
3910 Q1= PEEK (C+8*K+J)
3920 IF Q1=0 THEN 3990:Q= PEEK
     (N+Q1)
3930 IF Q#Z THEN 3940:O=Z:  RETURN

3940 IF O+Q#257 THEN 3950:O=Z:  RETURN

3950 IF Q=1-Z THEN 3990:O=Q
3990 NEXT J:  RETURN
3995 REM  OUTPUT THE NODE STATES
4000 T=1
4010 FOR K=1 TO 255
4020 IF PEEK (N+K)>1 THEN 4100
4030 TAB T:  PRINT K;":  "; PEEK
     (N+K);
4040 T=T+8:  IF T<40 THEN 4100
4050 T=1:  PRINT
4100 NEXT K:  PRINT :  GOTO 50
4500 REM  OUTPUT THE CIRCUIT
5000 FOR K=1 TO 63
5010 G= PEEK (C+8*K):  IF G=0 THEN
     5200
5020 PRINT K;:  TAB 4
5030 PRINT A$(A(G),A(G+1)-1);
5040 T=10
5050 FOR J=1 TO 7:G= PEEK (C+8*
     K+J)
5060 IF G=0 THEN 5100
5070 TAB T:T=T+4:  PRINT G;
5100 NEXT J:  PRINT
5200 NEXT K
5210 GOTO 50
6000 END
```



Apple Star-Trek

by Robert J. Bishop

APPLE STAR-TREK is an additional version of the "STAR-TREK" type of games in which you must find and shoot down the "bad guys," the Klingons. The rules are very similar to most STAR-TREK games.

RULES

The galaxy is divided into 64 quadrants arranged in an 8x8 grid; each quadrant is further subdivided into 8x8 sectors. Your mission is to find and destroy the seven Klingon spaceships hiding somewhere in the galaxy; you are allotted 15 stardates and have two starbases at which you can refuel. You are initially supplied with three photon torpedoes and 500 units of energy. Your energy supply is used to (a) move you around the galaxy, (b) fire your phasers, and (c) protect the Enterprise via its deflection shields which are automatically activated by the on-board computer every time a Klingon fires at you.

Each time you enter or maneuver within a quadrant containing a Klingon, he will shoot at you, and the amount of damage his phasers did to your shields will be indicated. Each time you shoot at him with either phasers or photon torpedoes and fail to destroy him, he will also return fire upon you.

COMMANDS

There are six commands available to you; they are numbered from 0 to 5:

COMMANO	FUNCTION

0 Moves the Enterprise. Computer responds with: "VECTOR ?", to which you must specify the number of sectors you wish to move, both horizontally and vertically. A positive horizontal move is to the right, and a positive vertical move is up. These two vector components must be separated by a comma; for example: −21,35 would move the Enterprise 21 sectors to the left of its current position, and 35 sectors up.

1 Short Range Sensor Scan. Prints the quadrant you are currently in, with the Enterprise represented by the symbols: <*> , Klingons represented by: +++ , starbases by: >!< , and stars by: *.

2 Long Range Sensor Scan. Displays a 3x3 array of "nearest neighbor" quadrants with the Enterprise's quadrant in the center. The scan is coded in the form: KBS, where K is the number of Klingons, B is the number of starbases, and S is the number of stars in the quadrant.

3 Fire Phasers. The computer informs you as to how much total energy you have left, and then waits for you to indicate how much of that energy you want to fire at the enemy. (Note: the closer you are, the more effect your phasers will have on the Klingons, and conversely!)

4 Fire Photon Torpedo. You have no control over the course of the torpedo; the on-board computer automatically aims at the enemy, taking care to avoid hitting any intervening stars or starbases. (Again, the closer you are, the better your chances of hitting the Klingon.)

5 Library Computer. The library computer allows for the following two requests:

REQUEST = Zero:	Cumulative record of the results of all previous long-range sensor scans of the galaxy.
REQUEST = Non-zero:	Status Report

EXPENDITURE OF SUPPLIES

Moving from one quadrant to another uses up energy and one stardate. However, movement within a given quadrant uses up only energy.

RELATIVE POSITIONS CHANGE WITH TIME

Much can happen in a few stardates! Consequently, if you leave a quadrant and then later return, don't expect the Klingons, stars, etc. to still be in the same relative positions that they were in when you left! The number of each will still be the same, but their positions will be different. This means that whenever you enter a new quadrant, you don't know just where the various objects will be; in fact, don't be too surprised if once in a while you collide with things!!!

REPLENISHMENT OF SUPPLIES

Docking at a starbase re-initializes your supply of photon torpedoes to 3, and your energy supply to 500. Docking is accomplished by moving the Enterprise to any one of the four sectors immediately adjacent a starbase, above, below, left, or right.

BATTLE RETREAT

Firing zero units of phaser energy will return you to command mode. This allows you to retreat from battle.

GALAXY CO-OROINATE SYSTEM

Quadrant 0,0 is the lower left hand quadrant of the galaxy, and quadrant 7,7 is the upper right. Likewise,

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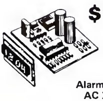

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74LS02—49c	7420—19c	7474—35c	7493—69c	74161—95c
7404—19c	7430—19c	74LS74-59c	7495—75c	74164-1.10
74L04—29c	7432—34c	7475—69c	7496—89c	74165-1.10
74S04—44c	7437—39c	7476—35c	74121-38c	74174—95c
74LS04-49c	7438—39c	7480—49c	74123-65c	74181-2.50
7406—29c	7440—19c	7483—95c	74132-1.70	74191-1.25
7408—19c	7447—85c	7485—95c	74S138-1.95	74192-1.25
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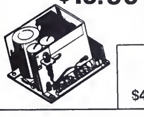

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sector 0,0 is in the lower left hand corner of the quadrant and 7,7 in the upper right. (Thus, the galaxy resembles a Cartesian co-ordinate system with the x-axis pointing to the right, and the y-axis pointing up.)

PROGRAM MODIFICATIONS

The APPLE STAR-TREK program is written in APPLE BASIC and uses most of the available memory. Any attempts to expand or modify the program are done at your own risk!

Program Listing

```
10 DIM C$(6),D$(15)
20 Q=640 S=704 D$="    * >!<+++(*)
   "
30 INPUT "TYPE A NUMBER ",R
40 FOR J=1 TO R C= RND (256):
    NEXT J
50 8=Q: GOSU8 1100
60 S1=75 N=S1 V=1 L=18  GOSUB
   1208
70 B1=2 N=B1 V=10:L=28  GOSUB
   1200
80 K1=7 N=K1 V=20 L=40  GOSUB
   1200
90 T=15  GOSUB 1300 E0= RND (
   4896). GOSUB 1400  GOSUB 1000

110 PRINT   INPUT "COMMAND ",C:
    IF C<8 OR C>5 THEN 118  GOTO
   100*C+200
200 INPUT "VECTOR ",X,Y X0=X0+
   X Y0=Y0+Y E1=E1- ABS (X)- ABS
   (Y)
210 IF X0<0 OR X0>63 OR Y0<0 OR
   Y0>63 THEN 250
220 E0=E0+X+64*Y:Q1=Q0 S1=S0  GOSU8
   1400  IF Q0=Q1 THEN 255
230 E1=E1-25 T=T-1:  GOSUB 1000
    GOSU8 1480  IF T>=0 THEN
   268
240 C$="TIME".  GOTO 980
250 C$="GALAXY"  GOTO 980
255 POKE S+S1,0:  GOSUB 1050
260 GOSUB 1880  IF B2=0 THEN 290
    IF ABS (X6-X2)+ ABS (Y6-
   Y2)#1 THEN 290
270 PRINT "- DOCKED -"  GOSUB
   1380 B1=81-1 82=8
280 POKE Q+00, PEEK (Q+Q8)-10
    POKE S+X6+8*Y6,0  GOTO 118

290 IF K2#0 THEN GOSUB 550  GOTO
   110

300 C$="SHORT"  GOSU8 350  GOSUB
   2000  GOTO 110
350 PRINT C$," RANGE SENSOR SCAN"
    GOSUB 360  RETURN
360 PRINT "FOR QUADRANT ";X1;","
   ;Y1  RETURN
400 C$="LONG"  GOSUB 358 N=3  GOSU8
   800
410 FOR Y=Y1+1 TO Y1-1 STEP -1
   F2=8  IF Y<0 OR Y>7 THEN
   F2=1. GOSUB 478  GOSUB 480

420 FOR X=X1-1 TO X1+1 F1=0  IF
   X<0 OR X>7 THEN F1=1
430 IF F1=0 AND F2=8 THEN 440
    PRINT C$,. GOTO 460
440 Q9=X+8*Y. GOSUB 1500  POKE
   Q+Q9,C9+40  PRINT "! ";K2;
   82,S2;" ",
460 NEXT X. PRINT "!"  GOSUB 480
    NEXT Y: GOSUB 478  GOSUB
   890  GOTO 110
470 C$="+-----": GOSUB 1600  RETURN

480 C$="!     "  GOSUB 1600  RETURN

500 IF K2=0 THEN 698  GOSUB 790
    PRINT "ENERGY  ";E1  INPUT
   "FIRE ",C: IF C<1 THEN 110

520 E1=E1-C  GOSUB 1800 K5=K5-
   C/R  IF K5>O THEN 530  GOSUB
   1900  GOTO 110
530 GOSUB 550  GOTO 588
550 J5=K5/5.K5=K5-J5 E1=E1-J5/
   R  PRINT J5/R," UNITS OF PHASER
    DAMAGE"  GOSUB 1800  RETURN

600 IF K2=O THEN 690  IF E2#0 THEN
   610  PRINT "NO MORE TORPEDOES"
    GOTO 110
610 E2=E2-1  IF R> RND (15) THEN
   640  GOSUB 1900  GOTO 110
640 PRINT "YOU MISSED!"  GOSUB
   550  GOTO 110
690 PRINT "NOTHING TO SHOOT AT!"
    GOTO 110
700 INPUT "COMPUTER REQUEST ",
   C  IF C=0 THEN 800
710 PRINT "STATUS REPORT:": PRINT
720 GOSUB 790  PRINT "KLINGONS ="
   ,K1
730 GOSUB 790  PRINT "STARDATES ="
   ,T
740 GOSUB 790  PRINT "STARBASES ="
   ,B1
750 GOSUB 790  PRINT "TORPEDOES ="
   ,E2
760 GOSUB 790  PRINT "ENERGY ="
   ,E1
770 GOTO 110
790 PRINT "REMAINING ";:  RETURN
800 PRINT " GALACTIC MAP": PRINT
   " ",: GOSUB 368 C$=" ---":
   N=8
810 GOSUB 880  FOR Y=7 TO 0 STEP
   -1:  GOSUB 1600
820 FOR X=8 TO 7 Q9=X+8*Y  GOSUB
   1500 P= PEEK (Q+Q9)
830 IF P>39 THEN 840  PRINT "    "
   ;: GOTO 850
840 PRINT " ",K2;B2,S2;
850 NEXT X  PRINT
860 NEXT Y  GOSUB 1600  GOSUB
   898  GOTO 110
880 B8=B2 K8=K2.  RETURN
890 B2=B8 K2=K8  RETURN
980 PRINT . PRINT "-- OUT OF "
   ;C$," --"
990 PRINT "YOU LEFT ",K1;" KLINGONS
   ": END
1000 B=S  GOSUB 1100 Q9=Q0  GOSU8
    1500  POKE Q+Q9,C9+40
1010 N=S2 V=1 L=2  GOSU8 1200
1020 N=K2 V=3 L=4  GOSUB 1200 K5=
    100 Y5=I/8 X5=I-8*Y5
1830 N=82 V=2 L=3  GOSU8 1200 Y6=
    I/8 X6=I-8*Y6
1035 C$="GREEN"  IF K2#0 THEN C$
    ="RED!". PRINT : PRINT "STARDAT
    E  ";3278-T,",  CONDITION  "
    ;C$
1040 PRINT "QUADRANT ";X1;",";Y1;
    "  -  SECTOR ";X2;",";Y2
1050 P= PEEK (S+S0): POKE S+S8,
    4  IF P=0 THEN RETURN
1060 PRINT   PRINT "*** COLLISION WI
    TN A ",
1070 IF P=1 THEN PRINT "STAR";:
     IF P=2 THEN PRINT "STARBASE"
    ,  IF P=3 THEN PRINT "KLINGON"
    ;
1080 PRINT " ***": IF P=3 THEN
    K1=K1-1  GOTO 990
1100 FOR K=0 TO 63: POKE B+K,0:
     NEXT K  RETURN
1200 IF N=0 THEN RETURN   FOR K=
    1 TO N
1210 I= RND (64):P= PEEK (B+I):
     IF P+V>=L THEN 1210  POKE
    B+I,P+V  NEXT K: RETURN
1300 E1=500 E2=3: RETURN
1400 Y8=E0/64 X0=E0-64*Y0 Y1=Y8/
    8 X1=X0/8 Y2=Y8-8*Y1. X2=X0-
    8*X1
1410 Q0=X1+8*Y1 S0=X2+8*Y2 R= ABS
    (X5-X2)+ ABS (Y5-Y2). RETURN
1500 C9= PEEK (Q+Q9): IF C9>=40
     THEN C9=C9-40
1510 S2=C9-10*(C9/10):K2=C9/20
    B2=(C9-S2-20*K2)/18  RETURN

1600 FOR J=1 TO N  PRINT C$;  NEXT
    J  PRINT C$(1,1). RETURN
1800 IF E1>0 THEN RETURN
1810 C$="ENERGY"  GOTO 980
1900 PRINT "*** BOOM ***" K1=K1-
    1.K2=0  POKE Q+Q0, PEEK (Q+
    Q0)-20  POKE S+X5+8*Y5,0
1910 IF K1 THEN RETURN . PRINT
     PRINT "MISSION ACCOMPLISHED!"
    . END
2000 C$="+---".N=8  GOSUB ...
2010 FOR Y=7 TO 0 STEP -1  FOR
    X=0 TO 7
2020 P=3* PEEK (S+X+8*Y)+1  IF
    X=8 THEN PRINT "!",  IF X#
    0 THEN PRINT " ",. PRINT D$
    (P,P+2),
2030 NEXT X  PRINT "!"  IF Y=0 THEN
    2040  PRINT "+";  TAB 33: PRINT
    "+"
2040 NEXT Y: GOSUB 1600  RETURN
```

JOHN CONWAY'S GAME OF LIFE

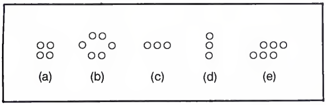
Programmed by Alan R. Miller

INTRODUCTION

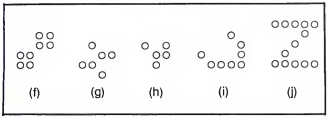
John Conway's game of life is described in Scientific American October 1970 and February 1971, and in such collections as *101 Basic Games* and *What To Do After You Hit Return.* Life deals with the life and death of counters which may be likened to living organisms, on a rectangular grid of cells. Counters are placed in various cells and the game begins. Each counter can have a maximum of eight neighbors: UP, DOWN, LEFT, RIGHT and the four DIAGONALS. Those with exactly two or three neighbors survive until the next generation. Those with more, "die" of overpopulation (are removed), and those with less, "die" of isolation. An empty cell with exactly three neighbors becomes a birth cell (a counter appears), otherwise it remains an empty cell for the next generation. Some groups of counters form patterns that are stable, others form patterns that oscillate or that disappear altogether.

LIFE PATTERNS

Two stable patterns are a "block" (a) and a "beehive" (b).



Three horizontal counters produce a "blinker" (c) that alternately changes to three vertical counters (d). Five horizontal counters produce four sets of blinkers and ten horizontal counters generate a repeating series of 15 patterns. Other blinkers will be formed from the "frog" (e), the "beacon" (f) and the "clock" (g).



A "glider" is a sequence of patterns that continually repeat, but move along in the process. The initial patterns shown in (h) and (i) produce gliders that respectively move downward and to the right. A five-by-five Z (j) will produce two such gliders moving off in opposite directions. Single diagonal rows called "fuses" lose the two end members each generation until all have disappeared (burned up). "Capping" one end makes it stable and starting with various configurations at the other end results in "dirty" fuses that spew out all sorts of things.

The Scientific American articles describe many other patterns such as glider guns that regularly eject gliders, glider eaters that gobble them up, and a Cheshire cat that slowly disappears first to a grin then to just a paw print.

MEMORY REQUIREMENTS

LIFE requires 420 bytes of memory including stack space plus 1024 bytes of work space in addition to the VDM memory. The object program is assembled for 5400 to 55AC Hex (52000 to 52654 Octal) with a work space from 5600 to 59FF Hex (53000 to 54777 Octal). The following locations may need to be changed to suit your VDM address, keyboard address, and others.

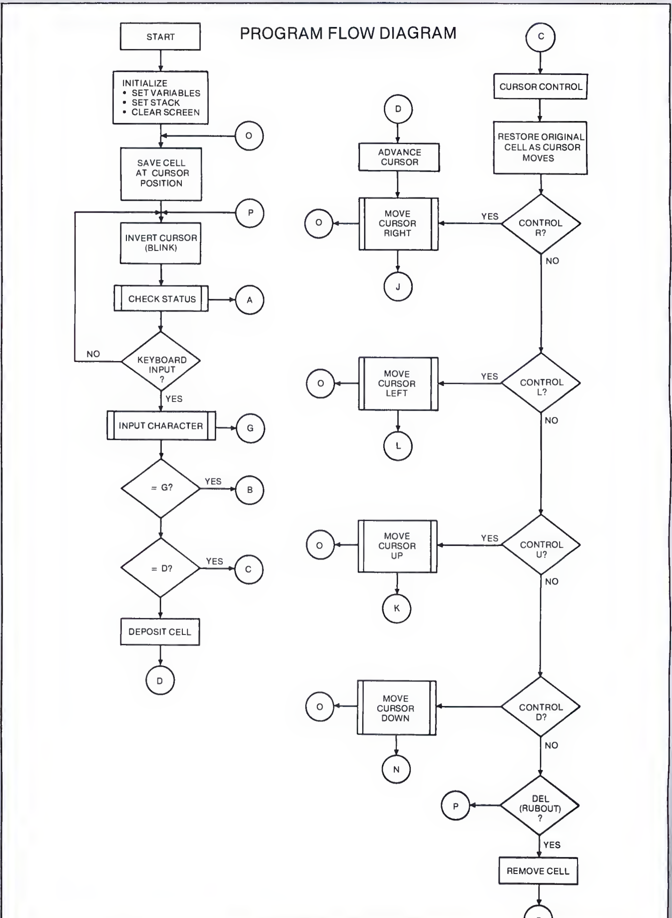
	Address (Hex)	Data (Hex)
Define stack	5401,2	55AC
Define work space	5526,7	5600
Keyboard status address	5461	10
Keyboard data address	5466	11
Data-available mask	5463	01
Jump (not) zero	544B, 5563, 5596	CA
VDM port address	542F	C8
VDM memory (start)	5404,5; 5523,4; 554B,C	F400
VDM memory (high byte)	551B	F4
VDM top + 1 (high byte)	5512	F8
VDM memory (center)	5436,7	F61F
Return on Control-X	546C,D	0000

MICROCOMPUTER CONFIGURATION LIFE OBJECT CODE DUMP

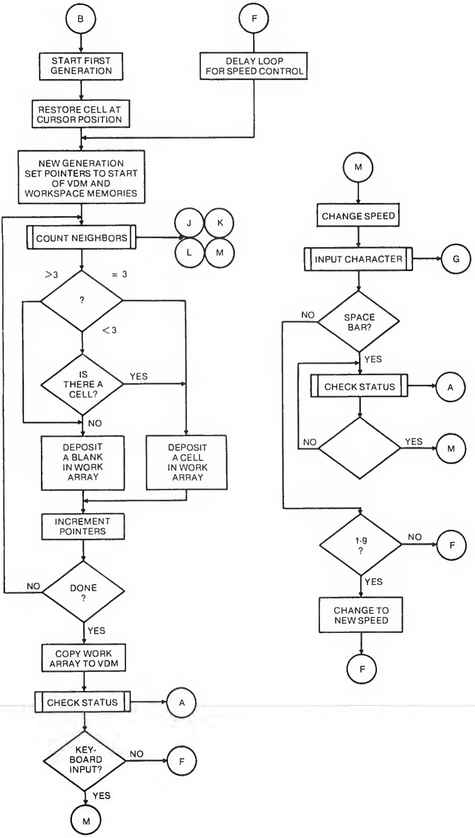
The present program is written for an Altair with a keyboard at 20/21 octal. A processor technology VDM addressed to F4 hex (172000Q), with a port address of C8 hex (310Q). The program is executed from the beginning (124-000). A cursor appearing in the center of the screen can be controlled with the following commands:

LOWING COMMANDS:

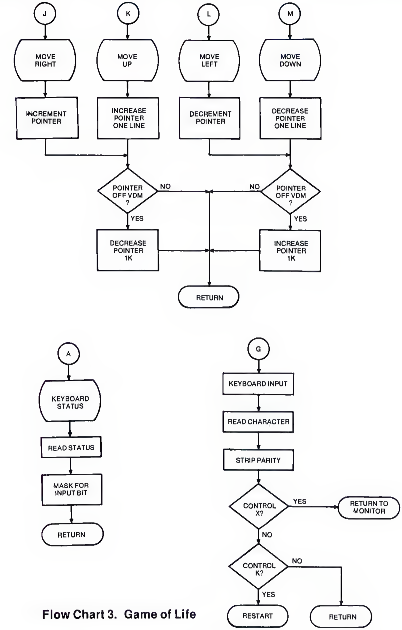
CONTROL-R	CURSOR RIGHT
CONTROL-L	CURSOR LEFT
CONTROL-U	CURSOR UP
CONTROL-D	CURSOR DOWN
D	DEPOSIT A CELL (CURSOR MOVES TO RIGHT)
G	(GO), START WHEN ALL CELLS DEPOSITED
DEL (RUBOUT)	DELETE A CELL
CONTROL-K	CLEAR SCREEN
CONTROL-X	JUMP ELSEWHERE (E.G. ADDRESS 0)



Flow Chart 1. Game of Life



Flow Chart 2. Game of Life



Flow Chart 3. Game of Life

PROGRAM SOURCE LISTING

```
                        ;THF GAME OF LIFF PHOGRAMMEO FOR A
                        ;PROCFSSOR TECHNOLOGY VIDEO OISPLAY MODULE
                        ;
                        ;BY ALAN R. MILLEH
                        ;
                        ;
                        ;
                        ;NFFOS 42Ø ØYTFS PLUS 1Ø24 BYTFS OF WOHK SPACE
                        ;ASSUMES PTCO VOM IS ADDRFSSFD TO F4ØØH,
                        ; WITH POHT AT C8H AND A KEYBOARD AT 1ØH (2ØQ)
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                                ORG     54ØØH    ;124-ØØØ/52ØØØQ
                        WORK    EQU     56ØØH    ;126-ØØØ/53ØØØQ
                        TYSTAT  EQU     1ØH      ;KEYBOARD STATUS ADDR.
                        TYDATA  EQU     11H      ;KEYBOARD DATA ADDHESS
                        INMASK  EQU     1        ;MASK FOR INPUT STATUS
                        VDMØAS  FQU     ØF4ØØH   ;START OF VDM MEMORY
                        VDMØ    EQU     ØF4H     ;HIGH ØYTE OF VDMBAS
                        VDMT    EQU     ØF8H     ;4+ HIGH ØYTE OF VDMBAS
                        CENTEK  EQU     ØF61FH   ;MIDDLE OF VDM MEMORY
                        VDMDEV  FQU     ØCBH     ;VDM PORT ADDHESS (31ØQ)
                        CTRD    EQU     4        ;CURSOR DOWN
                        CTRK    EQU     ØØH      ;CLEAH SCREEN
                        CTRL    EQU     ØCH      ;CURSOR LEFT
                        CTRR    EQU     12H      ;CURSOR RIGHT
                        CTRU    EQU     15H      ;CURSOR UP
                        CTRX    EQU     18H      ;CONTROL X
                        RETURN  EQU     Ø        ;ADDRESS OF YOUR MONITOR
                        TOKN    EQU     4FH      ;DEFINE TOKEN SYMBOL
                        ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
                        ;
                        ;INITIAL ENTHY, CLFAR SCHFEN ANO
                        ;               INITIALIZE CURSOR
                        ;
5400  31AC55            STAHT:  LXI     SP,STACK
54Ø3  21ØØF4                    LXI     H,VDMBAS ;POINT TO START OF VDM
54Ø6  7C                        MOV     A,H
54Ø7  C6Ø4                      ADI     4        ;A POINTS TO TOP OF VDM
54Ø9  362Ø              CLH2:   MVI     M," "    ;STORF BLANK IN MEMOHY
54ØB  23                        INX     H        ;INCRFMENT POINTER
54ØC  BC                        CMP     H        ;TOP OF VDM?
54ØD  C2Ø954                    JNZ     CLR2     ;NO
541Ø  AF                        XRA     A
5411  329D55                    STA     BOSL     ;INITIALIZF VDM
5414  329E55                    STA     BOTL     ;SCRFEN PARAMETFHS
5417  329B55                    STA     CCP
541A  2F                        CMA
541B  329C55                    STA     CURF
541F  3FØF                      MVI     A,15
542Ø  329A55                    STA     CLN
5423  3A9D55                    LOA     BOSL
5426  Ø7                        RLC
5427  Ø7                        RLC
5428  Ø7                        HLC
5429  Ø7                        RLC
542A  219F55                    LXI     H,BOTL
542D  Ø6                        OHA     M
542F  D3CB                      OUT     VDMDEV
543Ø  3FØ2                      MVI     A,2
5432  329F55                    STA     SPEFD
5435  211FF6                    LXI     H,CENTER ;PUT CURSOR IN CENTER
```

```
5430  46       NFWCEL: MDV     B,M      ;SAVE CUR0ENT CELL IN B
5439  114B80   BLINK:  LXI     O,40R    ;BLINK SPEED
543C  3E80             MVI     A,B0R    ;TURN ON LEFT BIT
543E  86               ADD     M        ;INVE0T CELL
543F  77               MDV     M,A
5440  15       OELAY:  DC0     O        ;BLINK TIMING
5441  C24054           JNZ     DELAY
5444  ID               DCR     E
5445  C24054           JNZ     DELAY
5448  CO6054           CALL    STATIIS  ;KEYBOA0D INPUT?
5448  CA3954           JZ      0LINK    ;NO
544F  CD6554           CALL    INPUT    ;YES, G0 GET IT
5451  FE47             CPI     "G"      ;IS IT A G (FOR G0)?
5453  CA2155           JZ      GD       ;YES, STA0T THE GAME
5456  FF44             CPI     "O"      ;A D (FDR DEPOSIT)?
5458  C27454           JNZ     CRIGHT
545B  364F             MVI     M,TDRN   ;OEPOSIT CFLL
545D  C37A54           JMP     CR2      ;ANO MOVE CURSDR RIGHT
                       ;
                       ;SUBROUTINE TO CHECK KEYBOARO-INPUT STATUS
                       ;
5460  OR10     STATUS: IN      TYSTAT   ;CHECK KEYBOARO STATUS
5462  E601             ANI     INMASK   ;MASK UNWANTEO BITS
5464  C9               RET
                       ;
                       ;SU0ROUTINF TO INPUT OATA FROM KEYBOARO
                       ;
5465  OBII     INPUT:  IN      TYOATA   ;KFYBOARO OATA PORT
5467  E67F             ANI     7FR      ;STRIP PARITY
5469  FF18             CPI     CTRX     ;RFTURN ON
546B  CA0000           JZ      RFTURN   ;CONTR0L X
546E  FF08             CPI     CTRK     ;CLFAR SCREEN ANO
5470  CA0054           JZ      START    ;RFSTART ON CONTROL K
5473  C9               RET
                       ;
                       ;CHECK FOR CURSOR MOVEMENTS
                       ;
5474  70       CRIGHT: MOV     M,R      ;RESTORE 0RIGINAL CELL
5475  FF12             CPI     CTR8     ;WAS INPIIT A CONTROL-R?
5477  C28054           JNZ     CLEFT    ;NO
547A  CD0155   CR2:    CALL    CURRT    ;YES, MOVF CURSOR RIGHT
547D  C33854           JMP     NFWCEL
5480  FF0C     CLFFT:  CPI     CTRL     ;WAS IT A CONTROL-L?
5482  C28B54           JNZ     CUP      ;NO
5485  CO1855           CALL    CURLF    ;YES, MOVF CURSOR LFFT
54K8  C33054           JMP     NEWCFL
548B  FF15     CUP:    CPI     CTRU     ;WAS IT A CONTROL-U?
5480  C29654           JNZ     COOWN    ;NO
5490  C00555           CALL    CURIIP   ;YES, MOVE CURSOR UP
5493  C33854           JMP     NFWCEL
5496  FF04     COOWN:  CPI     CTRD     ;WAS IT A CONTROL-0?
5490  C2A154           JNZ     OFLFTF   ;NO
549B  CO0C55           CALL    CUROWN   ;YES, MOVE CURSOR OOWN
549E  C33054           JMP     NFWCEL
54A1  FF7F     OFLETE: CPI     7FR      ;WAS IT A RUBOUT?
54A3  C23954           JNZ     0LINK    ;NO, WAIT FOR INPUT
54A6  3620             MVI     M," "    ;YFS, RFMOVF TOKEN
54AR  C37A54           JMP     C82      ;ANO MOVE CURSOR RIGHT
                       ;
                       ;SUBROUTINE TO COUNT NUMBER OF NEIGRBORS
                       ;(C RAS 3 MINUS THE NUMBER OF NEIGRBORS)
                       ;
54AR  0E03     COUNTN: MVI     C,3
54A0  2B               OCX     R        ;CRFCK LFFT CFLL
54AF  CD1955           CALL    TOOLO
5401  7F               MOV     A,M
5482  FF4F             CPI     TOKN     ;IS THERE A COUNTE0?
5404  C20854           JNZ     CNUL     ;JUMP IF NOT
5407  0D               OCR     C
5488  C00555   CNUL:   CALL    CURUP    ;CHECK UPPER LFFT CFLL
54R8  7F               MOV     A,M
54BC  FF4F             CPI     TOKN
54BF  C2C254           JNZ     CNT
54C1  00               OCR     C
54C2  C00155   CNT:    CALL    CURRT    ;CRFCK UPPFR CFLL
54C5  7F               MOV     A,M
54C6  FE4F             CPI     TOKN
54C8  C2CC54           JNZ     CNUR
54C0  00               OCR     C
54CC  C00155   CNUR:   CALL    CURRT    ;CRFCK UPPER RIGRT CELL
54CF  7F               MOV     A,M
5400  FF4F             CPI     TOKN
54D2  C20654           JNZ     CNR
5405  00               OCR     C
54D6  CO0C55   CNR:    CALL    CUROWN   ;CRFCK RIGRT CFLL
5409  7F               MOV     A,M
54DA  FE4F             CPI     TOKN
54DC  C2F054           JNZ     CNLR
54DF  00               OCR     C
54F0  CD0C55   CNLR:   CALL    CUROWN   ;CRECK LOWER RIGRT CFLL
54F3  7F               MOV     A,M
54F4  FF4F             CPI     TOKN
54F6  C2FA54           JNZ     CNB
54F9  00               OC0     C
54FA  CO1855   CN0:    CALL    CURLF    ;CRFCK BOTTOM CFLL
54E0  7F               MOV     A,M
54FF  FF4F             CPI     TOKN
54F0  C2F454           JNZ     CNLL
54F3  0D               DCR     C
54F4  CD1855   CNLL:   CALL    CURLF    ;CRECK LOWFR LFFT CFLL
54F7  7F               MOV     A,M
54F8  FE4F             CPI     TOKN
54FA  C2FF54           JNZ     CNF
54FD  0D               OCR     C
54FF  C00555   CNF:    CALL    CURUP    ;RFTURN CURSOR TO CFNTFR
                       ;
                       ;CURSO0-MOVEMFNT ROUTINFS
                       ;
5501  23       CURRT:  INX     R        ;MOVF RIGRT
5502  C31055           JMP     TOORI    ;IS CURSOR OFF SCRFEN?
5505  11C0FF   CU0UP:  LXI     O,0FFC0R ;MOVF UP
5508  19               OAD     O
5509  C31955           JMP     TOOLO
550C  114000   CUROWN: LXI     O,40R    ;MOVF OOWN
550F  19               OAD     D
                       ;
                       ;ROUTINF TO MOVE CURSOR OOWN IF OFF VDM
                       ;
5510  7C       TOORI:  MDV     A,R
5511  FFF8             CPI     VOMT     ;VDM TOP + 1
5513  08               RC
5514  DEB4             SBI     4
5516  67               MOV     R,A
5517  C9               RFT
5518  28       CURLF:  OCX     R        ;MOVE LEFT
                       ;
                       ;ROUTINF TO MOVE CURSOR UP IF OFF VDM
                       ;
5519  7C       TOOLO:  MOV     A,R
551A  FEF4             CPI     VOM0     ;RIGR BYTE DF VDM MEM.
551C  D0               0NC
551D  C604             ADI     4
551F  67               MOV     R,A
5520  C9               RET
                       ;
                       ;COUNTF0S RAVE BEEN DEPOSITED, START THE GAMF
                       ;
5521  70       GO:     MOV     M,B      ;RESTO0E LAST POSITION
5522  2180F4   NEXTGN: LXI     R,VOMBAS ;COUNT NEIGRBO0S
5525  118056           LXI     D,WO0K
5520  D5       NEXTFX: PUSR    O
5529  COAB54           CALL    COUNTN   ;COUNT NEIGRBDRS
552C  D1               POP     O
552D  79               MOV     A,C
552E  B7               O0A     A        ;3 NEIGRBDRS (A=B)?
552F  CA3F55           JZ      CELL     ;YES, DEPOSIT A TOREN
5532  7E               MOV     A,M
5533  FE4F             CPI     TOKN     ;IS THERE A TOKEN RERE?
5535  C23C55           JNZ     NOCELL   ;NO
5538  00               OC8     C        ;ARE THERE 2 NEIGRBORS?
5539  CA3F55           JZ      CELL     ;YES, OEPOSIT A TOKEN
553C  3E20     NOCFLL: MVI     A," "    ;NO, OEPOSIT A BLANK
553F  01               OB      1        ;MITS OB TRICK TO SRIP
553F  3E4F     CFLL:   MVI     A,TOKN   ;OEPOSIT A CELL
5541  12               STAX    D
5542  23               INX     R        ;INCREMENT POINTERS
5543  13               INX     O
5544  7C               MOV     A,R
5545  FFF8             CPI     0F8R     ;OONE?
5547  C22855           JNZ     NEXTEX   ;NO
                       ;
                       ;COPY WORK ARRAY TO VOM (O/E TO R/L)
                       ;
554A  2100F4           LXI     R,VDMBAS
5540  110056           LXI     O,WORK
5550  1A       COPY:   LOAX    O        ;COPY WORK TO A
5551  77               MOV     M,A      ;MOVE A TO VOM
5552  23               INX     R        ;INC0EMENT POINTE0S
5553  13               INX     O
5554  7C               MOV     A,R      ;CHFCK POINTER
5555  FFF0             CPI     BFBR     ;OONE?
5557  C25055           JNZ     COPY     ;NO
555A  3A9F55           LOA     SPEEO    ;TIMER
5550  57               MOV     D,A      ;MOVE SPEFO TO O
555F  1E80             MVI     E,88R
5560  CO6054           CALL    STATIIS  ;KEYBOARO INPUT?
5563  CA6055           JZ      NEXT2    ;NO
5566  C06554           CALL    INPUT    ;YES, CRECK FOR
5569  C07555           CALL    NUMCK    ;SPEEO CONTROL
556C  1B       NFXT:   OCX     D        ;DECREMENT OELAY BYTF
5560  7A       NFXT2:  MOV     A,D
556F  87               ORA     A        ;IS IT ZERO YET?
556F  C26C55           JNZ     NEXT     ;NO, WAIT SOME MORE
5572  C32255           JMP     NFXTGN   ;YES, GET GOINO
                       ;
                       ; CRECK FOR SPFEO-CONT0OL CHARACTER (1-9)
                       ;
5575  FE3A     NUMCK:  CPI     ":"      ;9+1
5577  029055           JNC     WAIT     ;TOO BIG, >9
557A  FF31             CPI     "1"
557C  DA9055           JC      WAIT     ;TOO SMALL, <1
557F  E60F             ANI     0FR      ;OR, REMOVE ASCII BIAS
5581  4F               MOV     C,A      ;MOVE OELAY VALUE TO C
5582  AF               XRA     A
5583  37               STC
5584  0D       LESS:   OCR     C        ;LOOP HE0E FOR OELAY
5585  CA8C55           JZ      FOUNO
5588  17               RAL
5509  C38455           JMP     LESS
558C  329F55   FOUNO:  STA     SPEEO    ;SAVE DELAY TIME
558F  C9               RET
                       ;
                       ;SURROUTINF TO FRFFZF THF SC0EEN
                       ; WREN SPACF BAR IS PRESSFO
                       ;
5590  FF20     WAIT:   CPI     " "      ;WAS INPUT A SPACE?
5592  C0               RNZ              ;NO
5593  CO6054   WAIT2:  CALL    STATUS   ;YES, WAIT FOR INPUT
5596  CA9355           JZ      WAIT2
5599  C9               RET
                       ;
                       ;STORAGF OF VOM SCREEN-CONTROL PARAMETERS
                       ;
559A  00       CLN:    OB      0        ;LINE NUMBER
559R  00       CCP:    O0      0        ;CURSOR POSITION
559C  00       CURF:   OB      0        ;CURSOR FLAG
5590  00       BOSL:   DR      0        ;BEG. OF SCREEN LINE
559F  00       0OTL:   O0      8        ;0FG. OF TEXT LINE
559F  00       SPFFO:  OB      0        ;DELAY BYTF
                               OS      12       ;SPACE FOR STACK
55AC           STACK:  OS      I
                               BEG     START
                               ENO     LIF
                               RUN     LIF
                       EOA
*
```

PROGRAM OBJECT LISTING

```
:10540000031AC552100F47CC60436202 3RCC20954BB
:105410 00AF329055329F55329R552F329C553F0F03
:10542000329A553A9D5507070707219F55R603CKAE
:1054300 03F02329F55211FF64611400 03F80R6777E
:10544000 15C24054 10C24054C06054CA3954C06574
:10545000 54FF47CA2155FF44C274543 64FC37A5491
:105460000010F601C90R11F67FFE1RCA0000FF0R67
:10547000CA0054C970FF12C28054C00155C33854RD
:1054R000FE0CC2R854C01855C33854FF15C2965429
:10549000CD0555C33854FF04C2A154CD0C55C33884
:1054A000 54FF7FC2395436 20C37A540F032RC01903
:10540000 557FFF4FC28854 00C00555 7EFF4FC2C27R
:1054C000 5400C001557FFF4FC2CC5400C001557FFD
:10540000FF4FC20654 00C00C557FFF4FC2F05400 8A
:1054F000CD0C557FFF4FC2FA5400CD1R557FFF4FR1
:1054F000C2F45400C018557FFF4FC2FF5400C00590
:10550000 5523C310 5511C0FF19C31955114000 1977
:105510007CFFF8080F0467C9287CFFF400C6046795
:105520 00C970 2100F41100560 5CDA0540 17987CA5A
:105530003F557FFE4FC23C5500CA3F553F20013F81
:1055400 04F1223137CFFF8C2285521 00F4110 05697
:105550001A7723137CFFF8C250553A9F55571E808R
:10556000C06054CA6055CD6554CD755518 7AR7C203
:105570006C55C32255FF3A029055FF310A9055F660
:10558000 0F4FAF3700CA8C5517C3 8455329F55C970
:10559000FF20C0CD6054CA9355C900000000000031
:0055A0000000000000000000000000000000 00FF
:000000
```

Letters to the Editor

Dear Editor:

As a recent subscriber I find your magazine very enjoyable. The sections listing new equipment are very helpful. While reading the March issue I came to a grinding halt on page 102 – The Qube – and felt obliged to write.

The Qube idea has been kicked around by some friends and myself on several occasions and we have come up with a few objections.

The absorption of a photon of appropriate energy to produce a change in atomic or molecular structure occurs at the atomic or molecular level. This absorption causes a change in the rotational or vibrational energy or electronic orbital structure of the atom or molecule involved and is independent of "candle power." In other words, the threshold for a transition depends on frequency, and therefore energy, not intensity. I am not aware of any materials that would behave the way Mr. Garrett wishes, but you never know what will turn up.

An analogy may be drawn using photographic emulsions. One could arrange the intensities of two lasers such that the emulsion at their intersection would (after processing) be black, but one would then have a gray at all points through which a single beam had passed. The same, I fear, would occur in Mr. Garrett's Qube. Diffraction would be a major problem for the same reason.

There is a ray of hope. Recent advances in epitaxial growth methods point to a possibility of producing a finished product that has much the same potential as the proposed Qube.

One last note, there is no way to intersect two cylindrical beams and get a sphere.

Charles Springer
Gig Harbor, WA 98335

Why, so far, no responses from Silicon Valley?

-editor

Dear Editor:

I was totally enthralled by Edward Christianson's article on stock options in the February issue. His hard labors, and effective software were quite evident, and deserving of my vote as the best article of the month.

However, being a computer amateur, and a financial professional (I think), I must question the tone, and content of his article.

The author approaches the stock market (options) definitely as a "bull." A novice cannot but notice this in the body of his description, and the analytical examples he states. The market goes down, as well as it goes up, and over the short term which option trading favors, I fear the odds at loss are greater than gain.

Particularly troublesome to me was his use of proceeds, and his definition of break-even. To meet the criteria he describes, the market would have to be in an "uptick" (more up sales than down) on average for the length of the option in order to realize a profit from the sale. If not, the option buyer would be unlikely to excise the option. Therefore, the proceeds as used by the author are no longer based on the strike price (price on execution of the option) but now have evaporated to the market level. You as the seller are now stuck with the stock and locked in for the length of the option unless you sell another option, or sell the stock and become uncovered. However, your strategy has now become defensive probably in a sliding market. The break-even point is now greater since the proceeds are now at market value, and the profit if any reduced accordingly.

Perhaps the author's conditioning was based on reinvestment and compounding of the collected option immediately on receipt; if so, this did not come across in the arithmetic for the items I listed. However, if this was indeed his intention, one must point out that the risk is also compounded from high to potentially catastrophic. I'd hate to have my micro (et al) repossessed.

Dick Carideo
Malden, MA

Dear Editor:

I have some interest in stock options so the first article I read in February's issue was the one on "Microcomputer Stock Options".

I noticed that Examples 1 through 3 in the article showed that situations which offered greater opportunity for gain also had less risk as shown by higher return and lower break-even values. This is rarely, if ever, the case in the market. The problem is with the way the break-even value is computed. Edward Christianson does this by subtracting return from total cost. However, this return is based on the premise that the stock underlying the option will rise to or remain at or above the strike price of the option. If the stock fails to rise or worse yet, drops in value, the return is diminished or disappears altogether at the break-even point.

Break-even should be defined as total cost minus total receipts (from dividends and option premiums). The program can be fixed by replacing statement number 1520 as follows:

```
1520 R3 = (INT((C5-T2-T3)*100)/S1)/100).
```

James M. Pierce
Clarksville, Md.

Dear Editor:

It is always a temptation to try to get something for nothing. In your Vol. 2 Issue 3, February 1977, issue of INTERFACE AGE, there is an article on page 45 on building a 12 bit tracking Analog-Digital Converter. This type of ADC uses an internal 12 bit DAC which in this case is put together from two 6-bit DACs. This does not give 12 bit accuracy. This can be seen by considering the accuracy limitations on the more significant DAC. Normally it provides an output which should be accurate to at least ± ½LSB. However, when working with the additional DAC, its output LSB will be divided into 2^6 (=64) steps by this less significant DAC. Thus, to deliver 12 bit accuracy the LSB of the more significant DAC must actually be accurate to better than ½ X 1/64 of a step (which far exceeds the accuracy specifications of commercial products). Precision Monolithics, Inc., specifies their 6 bit DAC-01 as having 7 bits of accuracy. Thus, if two of them are put together, about 7 bits of accuracy can be expected, not 12 or 14 bits.

One would probably save money and gain in accuracy by using one 10 bit DAC to start with. If 12 bit accuracy is really needed (real 10 bit accuracy is usually sufficient), then a 12 bit DAC should be used.

Henry E. Schaffer
Professor of Genetics
North Carolina State University
Raleigh, N.C.

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51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
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301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325
326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350
351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375
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E ☐ Other

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A ☐ Immediate Purchase
B ☐ Purchase 30-60 Days
C ☐ Comparisons
D ☐ Literature Library
E ☐ Other ______

4. My Interest Emphasis Is
A ☐ Hardware
B ☐ Firmware
C ☐ Software
D ☐ Other ______

5. My Application Is
A ☐ Hobby Only
B ☐ Business Only
C ☐ Hobby & Business
D ☐ Instruction Purposes
E ☐ Research
F ☐ Design & Development
G ☐ Other ______

6. My *Primary* Source Of "State-of-the-Art" Information Comes From:
A ☐ Magazines
B ☐ Exhibits & Conventions
C ☐ Club Meetings
D ☐ Direct Mail From Manufacturers
E ☐ Other ______

7. I prefer To Buy
A ☐ Directly From Manufacturers
B ☐ Local Computer Retailer (Store)
C ☐ Mail Order
D ☐ Club Group Purchases
E ☐ Other ______

8. I Look To *INTERFACE AGE* First For
A ☐ New Product Information
B ☐ Software Information
C ☐ Tutorials
D ☐ Hardware Articles
E ☐ Product Advertising
F ☐ Remarks ______

Please send information on items circled below.

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